Overview

The introduction of the Propane powered Blue Bird Vision marks a new generation in alternative fuel powered school buses. The bus is powered by a General Motors, Vortec 8.1 Litre engine equipped with a Liquid Propane Injection (LPI®) fuel system. Unlike the traditional propane powered vehicle that supplies propane to the engine in a vapor phase, the LPI system delivers, meters and injects propane in a liquid phase into the engine.

Similar to a modern gasoline engine, the LPI®system stores liquid propane in the fuel tank. An electric in-tank fuel pump circulates the propane through fuel rails that supplies fuel sequentially to the fuel injectors. The injector's meter and inject liquid propane into each of the original eight inlet ports on the Vortec engine. Fuel that is not used by the injectors will return to the fuel tank through an in-line pressure regulator.

The operator should notice little differences in operating a propane versus a diesel powered bus. Similar to the starting procedure of a diesel powered bus, there will be a wait to start indicator informing the operator when to start the propane powered engine. The propane wait-to-start procedure is similar to that of diesel, but must be performed during each start up regardless of ambient temperatures. The operator will also notice a drop in engine noise as the propane powered engine has a noise level similar to that of a gasoline engine versus a diesel engine.

Fueling a propane powered bus will be noticeably different than a conventional fueled vehicle. A propane fuel system is completely sealed and the major difference when fueling is a screw-on type fill connector. When fueling, turn connector clockwise to tighten ensuring a good seal. The tank can only be filled to 80%, leaving room for the fuel to expand/contract and the tank is equipped with an automatic stop fill device to prevent filling more than 80%. At 80% the dash gauge will read full. Fill time is only slightly longer than refueling a diesel powered bus.

Propane

Propane, like diesel fuel, gasoline or natural gas, is a member of the hydrocarbon family and exists as a gas in its natural state. When stored under pressure, the propane turns into a liquid. Propane is a colorless, odorless and non-toxic gas. Ethyl mercaptan is added to propane during the manufacturing process to give it a distinct, recognizable odor. Propane is a by-product of refined petroleum and natural gas. Propane is commonly referred to as LPG or LP gas.

Like most liquids, liquid propane expands as its temperature increases. This is why propane tanks are only filled to 80% of its liquid capacity. Even with an 80% fill capacity, due to liquid propane's expansion ratio of 1:270 (liquid propane to a gas by volume) and its high BTU rating a large volume of energy can be stored in a relative small tank under relative low pressure.

Propane also has a very narrow range of flammability with a 2.15% threshold on the low side and a 9.6% threshold on the high side. This means that if the propane to oxygen mixture is lower than 2.15 % or higher than 9.6 % the mixture is noncombustible.

WARNING ***Technicians working with, or around, fuel systems should be properly trained to utilize extreme care and caution at all times. Failure to exercise extreme caution and care may lead to serious accidents which can result in property damage, personal injury and/or death.***

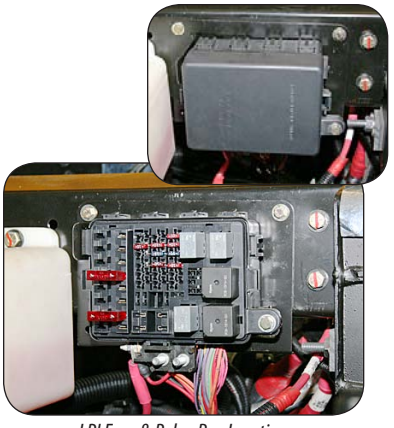
Propane is heavier than air; therefore, a leak in a propane fuel system can result in a gas accumulation in low places, such as sewers, drains or service pits. This can create a fire and health hazard as the propane will displace oxygen, potentially resulting in suffocation. For this reason, additional safety precautions should be observed when working on or around propane powered equipment or storage tanks.

WARNING ***Blue Bird does not approve any additions to or modifications of Blue Bird fuel systems. Blue Bird fuel systems are designed and installed to meet federal standards and engine manufacturer's guidelines. The maintenance provider or modifier assumes all responsibility for the vehicle engine and fuel system if the fuel system is changed or modified. Some states require a special license to perform maintenance or work on propane powered vehicles. Check with local authorities or your state LP Gas Association for details. All fuel system components must be a minimum of 18 inches from any exhaust sytem component unless properly shielded. All service, maintenance and repairs performed on LP Gas systems must be done by an authorized LP Gas service technician.***

Fuel System Description and Operation

The General Motors Vortec. 8.1L engines fuel supply is controlled by the same PCM (Powertrain Control Module) as used on the GM medium duty truck; however the fuel control calibration has been changed to optimize the power and emissions for propane. The LPI system controls the purge cycle while the original PCM controls fuel flow to the injectors. The filling process is safeguarded against overfilling by an electronic 80% overfill protection device integral to the LPI® system.

The LPI system utilizes dual cylindrical tank assemblies manifold together to store the liquid propane under pressure. Internal to the tank is an electric fuel pump with a replaceable filter, a fuel level float device with rheostat, an auto stop pressure sensor, an 80% liquid level sensor, a fuel fill stop solenoid, a supply check valve assembly, a fill port check valve assembly, a return check valve assembly, and a wiring harness.



LPI Fuse & Relay Box Location

Due to the inherent qualities of Propane, a purge strategy must be employed during engine start up. Whenever the fuel pump is not activated, there is a potential for the liquid propane in the fuel rails to absorb heat from the engine or from ambient temperatures. This heat may cause the fuel to expand rapidly and create bubbles in the fuel rails. These bubbles, if not purged from the fuel rails, can cause lean fueling or a no start conditions.

Fuel Control Unit

PurgeCycle

During each engine start up the LPI fuel system will enter a two-stage purge cycle for a period of approximately 20 to 30 seconds. The purge process is controlled by the Fuel Control Unit (FCU). The FCU is an electronic module that controls the LPI fuel system and functions independently of the engines PCM (Power Train Control Module) during the purge cycle. The first stage of the purge cycle will begin when the operator turns the key to the Key On Engine Off (KOEO) position, a wait-to-start-

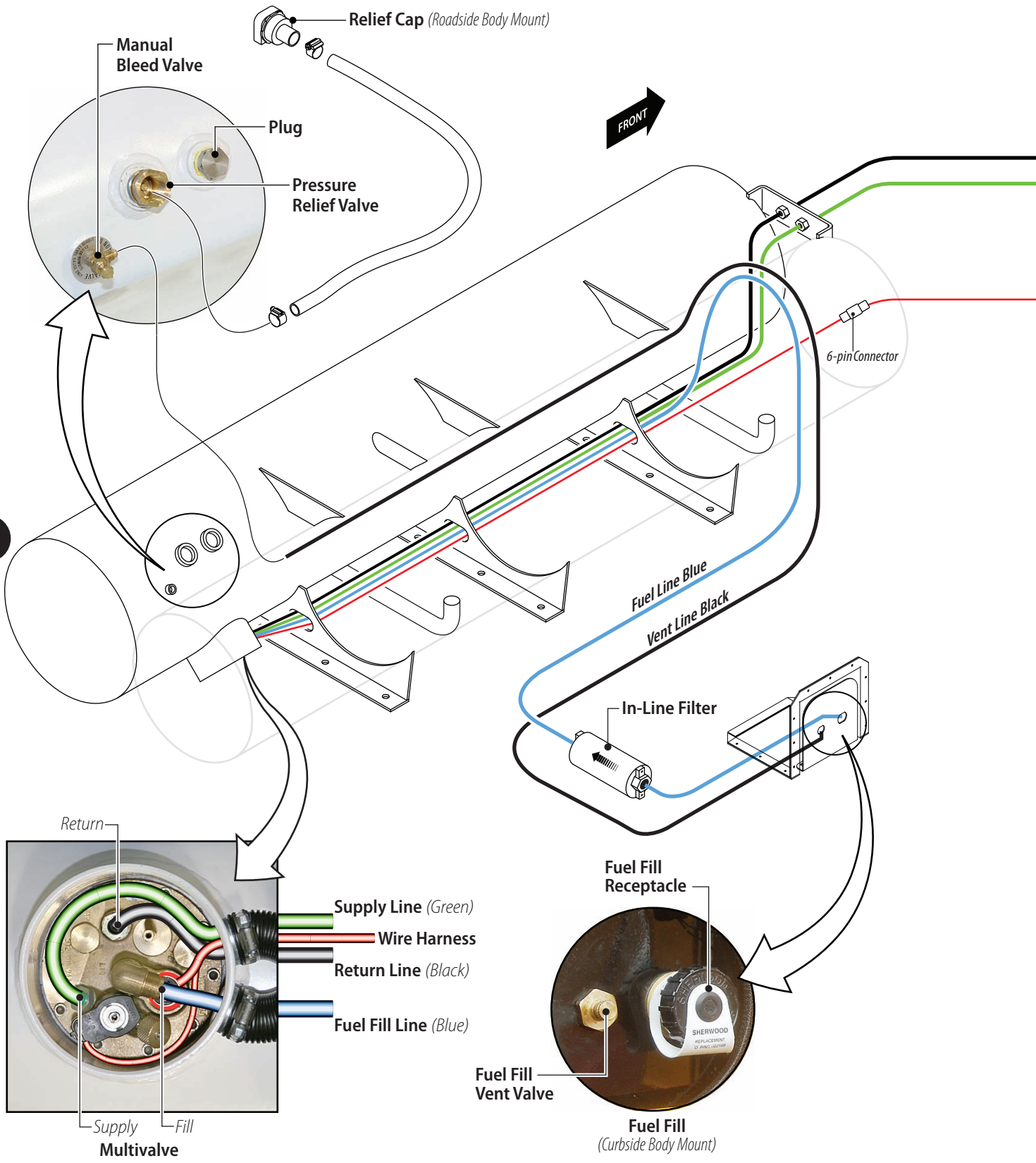
indicator in the instrument panel will illuminate for approximately 20 seconds. The FCU will then turn off the wait-to-start indicator marking the beginning of the second stage of the purge cycle. The operator should immediately start the engine. During the second stage of the purge cycle, the operator has approximately 10 seconds in which to start the engine. If the engine does not start or the operator waits too long (approximately 10 seconds) the wait-to-start indicator will begin blinking. This indicates that the purge cycle has been completed and has timed out at which time the FCU will de-energize the fuel pump and the engine will not start. The operator will have to repeat the purge cycle by turning the ignition key off and then back on to initiate a new purge cycle.

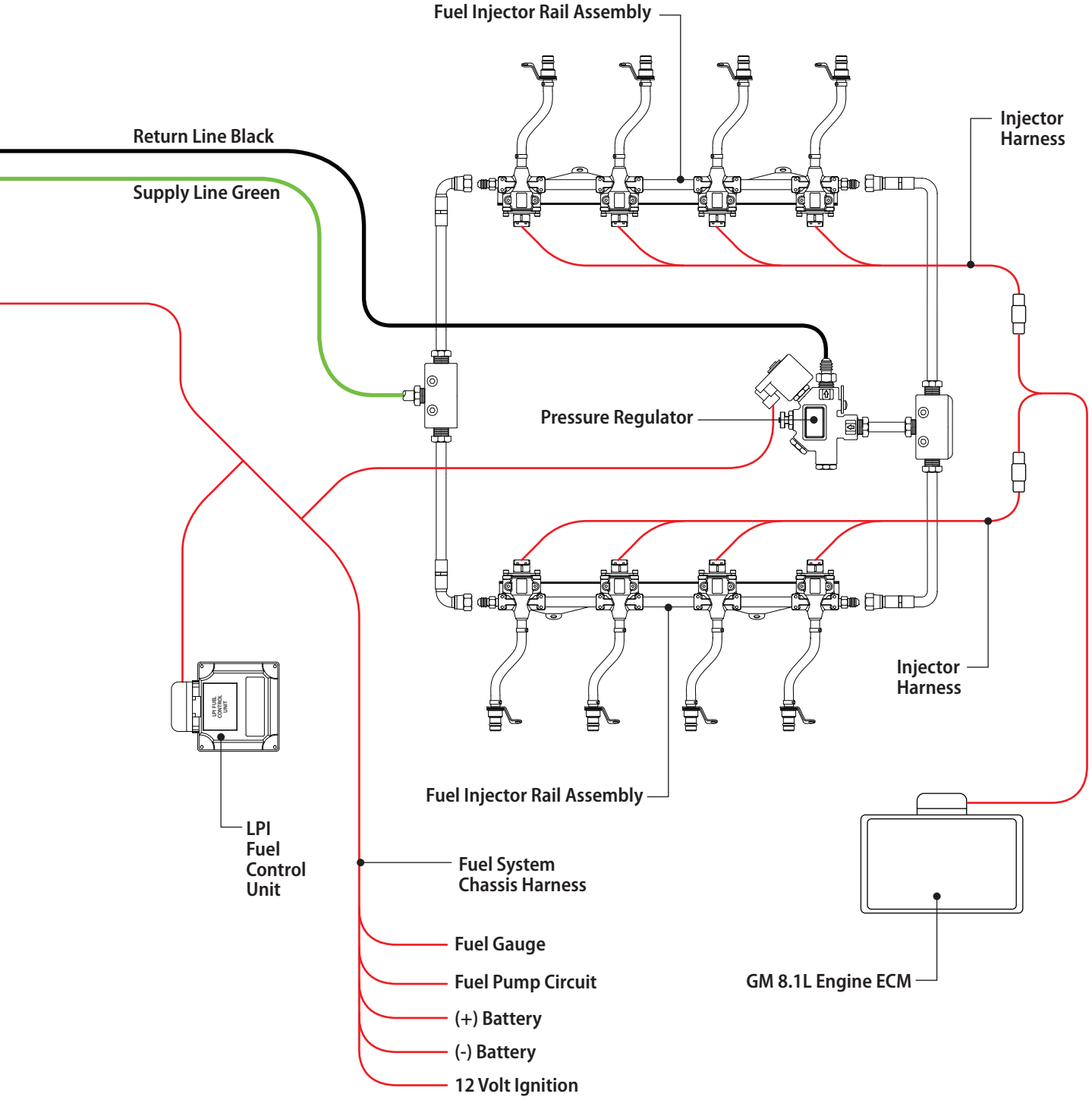
When the operator turns the key to the KOEO position the LPI Fuel Control Unit (FCU) supplies an electrical signal to the normally closed fuel supply solenoid (integrated into the multivalve), the normally closed fuel purge solenoid (integrated into the pressure regulator valve) and the fuel pump (located inside the fuel tank). Liquid propane will begin to flow through the green supply line, to the fuel rails and finally to the injectors. Fuel will flow back through the black return line to the pressure regulator, through the open purge solenoid valve and back to the fuel tank. This free flow circulation of liquid Propane will continue for approximately 20 seconds (stage one of the purge cycle) purging the fuel circuit of bubbles.

After the first stage of the purge cycle is completed, the FCU will turn the wait-to-start indicator and the purge solenoid off while keeping the fuel supply solenoid and the fuel pump energized for approximately 10 seconds. This 10 second period is stage two of the purge cycle. During stage two, propane will continue to flow through the fuel supply lines to the injectors. With the purge solenoid closed, fuel will no longer be able to bypass the fuel pressure regulator and return unrestricted to the fuel tank. Fuel flow will be regulated through the preset pressure regulator valve. By controlling the rate of fuel flow through the regulator, the necessary pressure for the fuel injectors to operate will be created and maintained by the fuel pressure regulator.

The Vortec engines, equipped with the LPI fuel systems, will have a unique calibration installed in the base engine PCM. Specific parameters and values have been slightly altered to optimize the base calibration to operate on Propane. By utilizing the base engine PCM, the LPI fuel system can utilize all the engine sensors and throttle control devices. The LPI fuel system controls the fuel pump and fuel flow to the injectors during the purge cycle and during normal operation fuel flow is control as required by the base engine PCM. The fuel injectors are specific to the LPI system, however, the electrical signals that control the injectors are provided solely by the engine PCM.

The LPI fuel system utilizes the base engine diagnostics to monitor the base engine fuel system and emission systems faults. This strategy allows the technicians to utilize the GM diagnostic tools and diagnostic charts when identifying base engine fuel and emission system faults. See **Appendix 1. Symtoms Diagnostic Charts** at the rear of this chapter.


Relief Cap (Roadside Body Mount)
Manual Bleed Valve
Plug
Pressure Relief Valve
FRONT
6-pin Connector
Fuel Line Blue
Vent Line Black
In-Line Filter
Return
Supply Line (Green)
Wire Harness
Return Line (Black)
Fuel Fill Line (Blue)
Supply
Fill
Multivalve
Fuel Fill Receptacle
Fuel Fill Vent Valve
Fuel Fill
(Curbside Body Mount)



Propane Fuel System GM 8.1L

General Propane Tank Filling Procedures

The most important procedure of filling any propane tank is safety. Understanding the properties & characteristics and safe handling practices of the fuel is required before conducting any propane tank filling efforts.

A propane powered vehicle is equipped with a propane tank built to and certified to the regulations of the American Society of Mechanical Engineers (ASME) These tanks have a data plate with pertinent information including the ASME stamp and the plate must be securely attached and legible or the tank should be taken out of service and replaced. There are no requirements for re-certifying ASME tanks however inspection is required and maintenance is recommended if there are signs of corrosion.

Propane tanks are filled to 80% capacity to allow for the liquid fuel to expand and contract depending on ambient or other influent temperatures. All tanks built for use on motor vehicles are equipped with overfilling prevention protection. The National Fire Protection Association (NFPA) have required motor vehicle propane tanks be equipped with a stop filling device to automatically prevent overfilling or filling the tank beyond the maximum recommended capacity of 80%. This automatic stop fill system provides the primary method of preventing overfill of the fuel tanks. This rule has been in effect since January 1, 1984.

As a secondary means of preventing an overfill condition of the fuel tanks and a means of verifying the accuracy of the automatic stop fill device, the tanks are equipped with an 80% fixed maximum liquid level outage valve (Manual bleeder valve). The valve would be used to verify when the liquid fuel reaches the 80% level at which point the fill process would be stopped. This valve can be used when filling and releases fuel in a vapor phase until the fuel reaches the 80% level at which time a stream of liquid will appear indicating the fuel level in the tank is 80%. Most propane fueling stations will want to open this bleeder valve however since the propane motor vehicle tank is equipped with an overfill prevention device it is not necessarily required and may be prohibited in certain municipalities where the release of hydrocarbons to the atmosphere is prohibited. The NFPA ruled that when the tank is equipped with an overfill prevention device the use of the 80% bleeder valve is not required.

WARNING ***Technicians working with, or around, fuel systems should be properly trained to utilize extreme care and caution at all times. Failure to exercise extreme caution and care may lead to serious accidents which can result in property damage, personal injury and/or death.***

Propane Powered Motor Vehicle Filling Procedures

1. Entering the propane fueling station.
   a. Park the vehicle in close proximity to the motor fuel dispensing station.

      WARNING ***NO SMOKING ALLOWED.***

2. Turn off and remove the vehicle ignition key.
3. Exit the vehicle and ask all passengers to step outside the vehicle.
   a. Some stations may ask all passengers to stand outside the area where the fill process is taking place.
   b. Some stations could be self-service and the driver would perform the filling process; however in this case the driver has to be trained and certified to obtain an authorized filling station dispenser access card.
4. The attendant may need to inspect the propane tank for corrosion, dents and verify the data plate displays the ASME stamp and other pertinent information is correct. An attendant can refuse to fill your propane tank if it does not pass this inspection. Regular inspection and maintenance of your tank will prevent refusal to fill the tank.
5. Verify the meter is set to zero.
   a. If the dispenser is an electronic dispenser it will set to zero automatically once the transaction has been initiated.
6. Connect the fuel nozzle to the vehicle fueling receptacle.
   a. The propane fueling nozzle has to be screwed on securely.
      i. Wear protective gloves while fueling a propane tank.
      ii. Remove the protective cap from the vehicle fueling receptacle.
      iii. Mate the nozzle coupling to the fueling receptacle.
      iv. Turn the nozzle coupling in a clockwise direction; two or three turns until secure. A soft rubber washer or o-ring seals the connection so over tightening is not required.
      v. Most nozzles for motor vehicle fueling are much like a gasoline type nozzle. The nozzles are also minimum bleed type for safety and to meet hydrocarbon release requirements in certain jurisdictions.
7. Turn on the propane dispenser/pump and begin the filling process.
   a. Open the nozzle to begin filling.
   b. Do not fill the tank based on a mechanical float gauge reading or the fuel level gauge on the dashboard.
   c. Pay attention and never walk away from the filling process.
   d. As a primary method of determining when the tanks are full (80% capacity) an 80% stop fill device will automatically stop the filling process when the liquid propane reaches an 80% liquid level capacity in the tanks.

WARNING ***For passenger safety, Blue Bird recommends all occupants disembark to a safety zone before fuel filling procedures take place.***

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e. As a secondary method of determining when the tanks are full (80% capacity) an 80% fixed maximum liquid level outage valve (Manual bleeder valve) can be used
   - Open the 80% fixed liquid level valve (located at the fill port)
   - Vapor will be vented from the valve during the filling process
   - When liquid propane begins to vent the from the valve the tanks have filled to 80% capacity
   - Immediately close the 80% fixed liquid level valve
   - Immediately close the filling nozzle

NOTE: The 80% fixed liquid level valve can be used to verify the accuracy of the automatic stop fill device.

8. Release or close the fueling nozzle.
   a. Turn off the fuel dispenser/pump.
   b. Carefully and slowly unscrew the fueling nozzle (unscrew counter clockwise).
      i. A minimum bleed nozzle should have released any pressure left in the space between the nozzle and the receptacle when closed and should not bleed any pressure when unscrewing the connection.
      ii. Some nozzles will have more pressure trapped between the nozzle and the receptacle so it is necessary to slowly unscrew the connection to allow pressure to bleed off before removing the nozzle completely. Some nozzles will be equipped with a small bleeder valve to release this trapped pressure before disconnecting the nozzle.
10. Replace the nozzle and fuel transfer hose on the dispenser.
11. Verify there are no leaks at the tank filling receptacle and replace the protective cap.
12. Document the amount of fuel received.
13. The fueling process is complete.

WARNING ***During a propane vehicle fueling process fuel may be emitted to the immediate area. There could be a combustible fuel mixture around this immediate area. The person performing the re-fueling process has total responsibility for safety in the immediate area.***

NOTES:

- It is unlawful to fill a non-compliant tank or a tank that posses a safety violation.
- Any person performing the re-fueling process must be trained and certified in the procedures of filling propane tanks and in the procedures of safe handling.

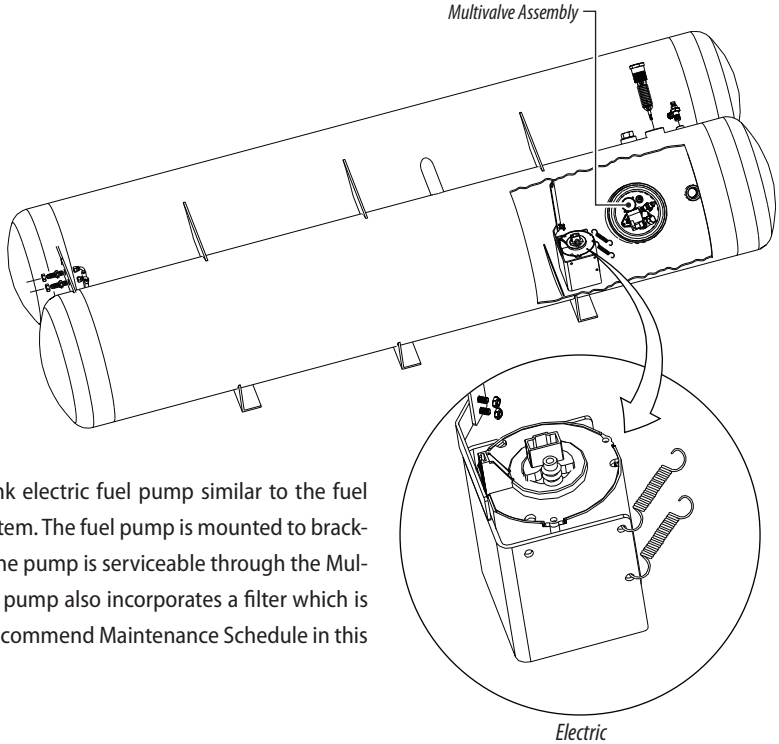
Propane Fuel Tanks

The LPI system utilizes a dual cylindrical manifold tank assembly to store the liquid propane. Only one of the tanks houses the LPI components which are mounted inside the tank or on the external surface of the tank. The other tank simply provides additional fuel volume. The two tanks are permanently connected by cross over tubes that create a single volume of fuel and therefore will be considered one fuel tank or tank assembly. The fuel tank is designed and certified to meet all applicable safety standards required for installation on a motor vehicle. The tank design utilizes integrated mounting brackets which are used for mounting the tank assembly between the frame rails. The tank assembly is secured to the chassis using specially coated and grade level fasteners.

The LPI fuel tank is fitted with a flange for mounting the Multivalve assembly on the bottom of the tank. In addition, a threaded coupling is fitted with a pressure safety valve that will open if tank pressure reaches 312 psi. The excessive pressure (propane vapor) is vented off and the integrity of the tank is protected. A second threaded coupling is fitted with a manual bleeder valve that is used for a maximum 80% liquid level indicator sometimes referred to as a bleeder valve, a fixed liquid level gauge or an outage gauge. The pressure safety valve and the manual bleeder valve are mounted on the top of the fuel tank near the multivalve assembly.

The following components are Inside the fuel tank; an electric fuel pump with a replaceable filter, a fuel level float device with rheostat, a fuel fill stop solenoid, an auto stop pressure sensor, an 80% liquid level sensor, a supply check valve assembly, a fill port check valve assembly, a return check valve assembly, and a wiring harness. The in tank components and their function will be discussed individually. All internal components are serviceable through the Multivalve flange opening in the bottom of the fuel tank.

CAUTION ***When servicing the tank or removing the tank from the vehicle be sure to reinstall the tank with the original fasteners or new like fasteners. Do not replace the fasteners with a lower grade of bolt than originally equipped as this may cause the tank to become dislodged from the vehicle and cause serious damage or injury.***



Electric In-Tank Fuel Pump

Electric In-Tank Pump

The LPI fuel system utilizes a 12 volt in-tank electric fuel pump similar to the fuel pump which is used with a gasoline fuel system. The fuel pump is mounted to brackets located in the bottom of the fuel tank. The pump is serviceable through the Multivalve flange opening in the fuel tank. The pump also incorporates a filter which is serviceable, for maintenance; refer to the Recommend Maintenance Schedule in this manual.

The in-tank pump receives a 12 volt supply when the ignition key is switched on and runs a purge cycle for approximately 20 seconds. The pump is provided with a constant ground signal. The LPI system utilizes the base vehicle fuel pump circuit which incorporates all the base vehicle safety features. To facilitate the purge cycle the LPI Fuel Control Unit (FCU) will override the PCM fuel pump circuit only for the 20 seconds during the purge cycle as the base PCM pump circuit has a much shorter time out strategy.

Fuel Gauge Driver

The tank is also fitted with an in-tank float and gauge driver which provides a standard linear signal with "0" ohms equaling an empty fuel tank and "90" ohms equaling a full tank (80% by liquid volume) of liquid Propane. The signal is routed to the instrument panel. The fuel gauge driver utilizes the base vehicle "anti-sloshing" signal condition originally programmed for a gasoline fuel system. The In-Tank Gauge Driver is serviceable through the multivalve flange opening.

Multivalve Assembly

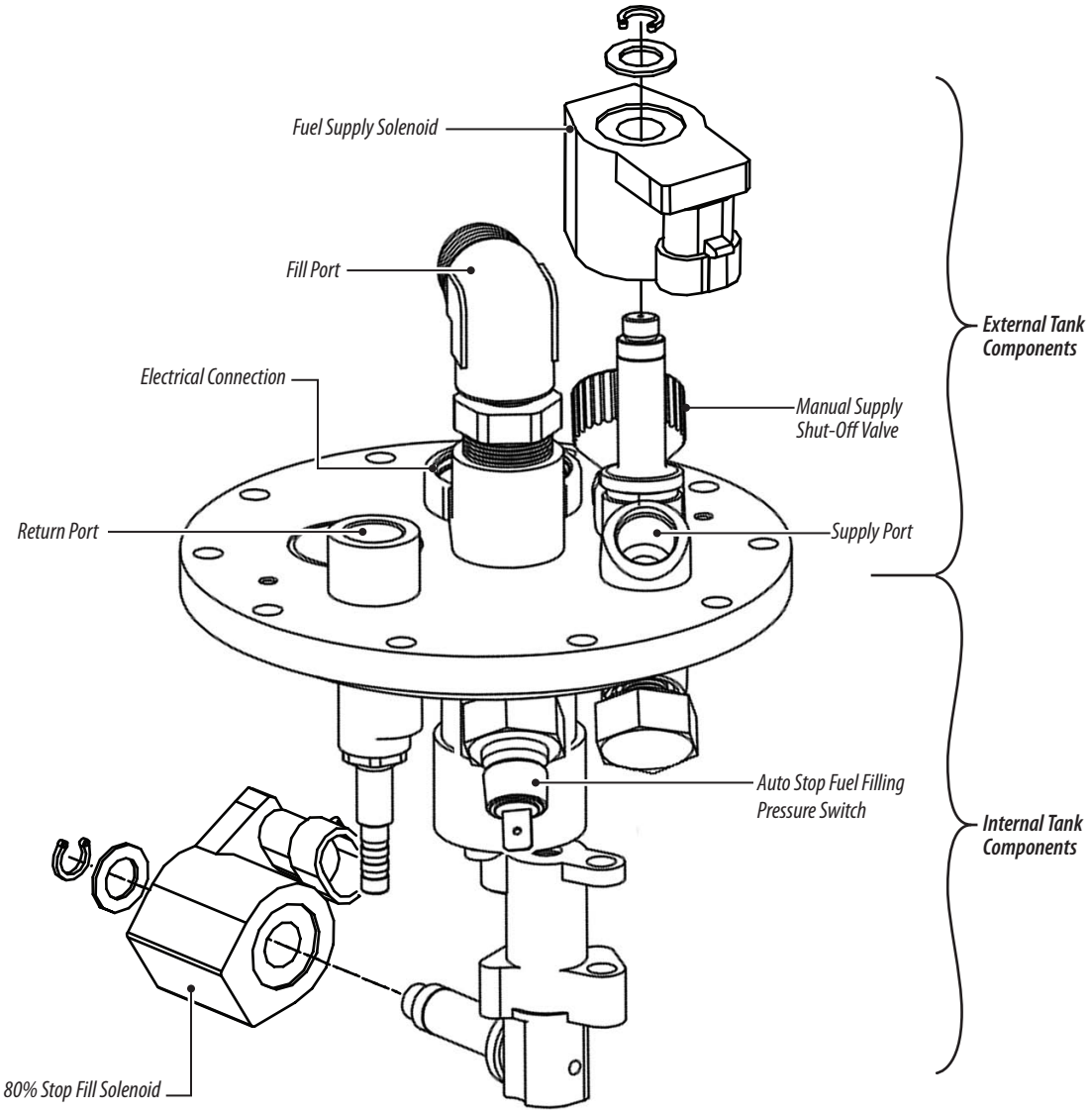
The LPI fuel system utilizes a unique Multivalve assembly that is flange mounted to the bottom area of the fuel tank. The valve assembly is attached to the tank with 10 fasteners and an o-ring seal that seals the valve to the flange. The Multivalve is a brass housing providing an integrated network of components mounted to the bottom and the top of the valve. The Multivalve assembly incorporates the following components:

Multivalve components, Bottom side (portion of the valve inside of the tank)

- An 80% Stop Fill Solenoid Valve Assembly
- An auto Stop fuel filling Pressure Switch
- A double back check fill valve assembly
- A double back check return valve assembly
- An wiring pass-through electrical connector

Multivalve components, Top side (portion of the valve outside of the tank)

- A Liquid Supply Solenoid valve assembly with electric and manual opening/ closing with excess flow protection.
- A fuel supply port
- A fuel return port
- A refueling port
- A wiring pass-through electrical connector



Multivalve Assembly

Refueling *(Automatic Stop Fill Cricuit)*

The 80% stop fill solenoid valve is an electrically actuated valve mounted to the bottom of Multivalve inside the fuel tank. The solenoid is a normally closed valve that prevents fuel flow through the fuel fill port (integrated into the Multivalve) when the solenoid is de-energized. When energized, the valve is equipped with a pressure differential sensor and will only open and allow propane to be pumped into the tank through the fill port if there is sufficient fueling station pump pressure, as described in more detail later in this section. As the tank reaches an 80% fill point by liquid volume, the solenoid valve will be de-energized, the valve will close and the fuel flow will be stopped. The 80% maximum capacity is to allow for the expansion of the liquid propane inside the fuel tank.

The 80% Stop Fill Solenoid is connected to a constant 12 volt positive signal. The solenoid will be energized or de-energized by switching the ground signal on and off. There are two requirements that must be satisfied before the solenoid receives a ground signal and allows fuel to be pumped into the fuel tank.

One of the requirements will be detected by the Auto stop fuel filling pressure switch. The switch is mounted to the bottom of the Multivalve and monitors the fuel fill port pressure during the refueling process. The sensor is a normally open switch and will close when it detects a differential pressure of 8.5 psi. The switch is connected to ground at it's mounting base and therefore provides a ground signal when closed. During the refueling process, liquid propane from the refueling station will be pumped into the fuel fill port (integrated in Multivalve). When the pressure switch detects a differential pressure of 8.5 psi between fuel tank pressure and the fill port pressure (created by the refueling station pump), the Auto Stop fuel filling Pressure Switch will close providing a ground signal to the Infra-Red 80% Liquid Level Sensor. This signal is one of the two requirements necessary to energize the 80% Stop Fill Solenoid and allow refueling of the fuel system.

The other requirement will be detected by the infra-red 80% liquid level sensor. The Sensor is mounted inside the fuel tank. The sensor monitors the liquid propane level in the fuel tank and is positioned to detect when the fuel reaches an 80% fill point by liquid volume. When the sensor detects a fuel level of 80% (wet sensor), it will open the electrical circuit to the 80% Stop Fill Solenoid. The solenoid will de-energized and remain closed preventing fuel flow into the fuel tank. When the sensor detects a fuel level below 80% (dry sensor) it will provide a ground to the Stop fill solenoid. The solenoid will open allowing the refueling process to take place. Keep in mind the 80% liquid level sensor receives its ground from the Auto Stop fuel filling Pressure Switch after its requirements has been satisfied.

The Auto Stop fuel filling Pressure Switch and the Infra-Red 80% Liquid Level Sensor are electrically connected in series to provide the stop fill solenoid with its ground signal.

Satisfying only one of the two requirements will not result in energizing the stop fill solenoid. It does not matter which of the two requirements are satisfied first, the fact is both requirements are necessary.

The Auto Stop fuel filling Pressure Switch must detect differential fill port pressure (created by refueling station pump) and send a ground to the Infra-red 80% liquid level sensor. The Infra-Red 80% Liquid Level Sensor must detect a liquid propane level in the fuel tank below 80% fill point. When these two requirements are satisfied, the 80% Stop Fill solenoid will be energize and the stop fill valve will open allowing the refueling process to take place. If one of the two requirements is not satisfied, the 80% Stop Fill Solenoid will be de-energized and the refueling process will be prevented.

Fuel Transfer Lines

The fuel transfer hoses utilized in the LPI fuel system are made of a unique material to provide long term protection and service. The hose end fittings may incorporate a swaged type fitting or a compression type fitting. The hoses are color coded to identify the supply, return and fill lines. Green fuel lines indicates supply from the pump to the fuel rail, black indicates return lines from the injectors back to the tank and blue indicates re-fuel lines. Fitting sizes are all metric, use the proper wrench size when removing and replacing the fittings or connectors.

A special tool is required to properly install the compression fittings. This tool can be secured from Clean Fuels. Part No. 90700000 Compression Tool.

NOTE: When replacing hoses use hoses made of the same material, size and color. Some hoses contain an internal spring guard to prevent kinking and or collapsing. Always route and secure hoses as originally installed

Fuel Rail Tee Block Assembly

Fuel is delivered to each rail via the Tee block located at the rear of the intake manifold. The Tee assembly is used to distribute the fuel evenly to each rail assembly. The Green hose connectors are assembled using compression type fittings on the end and swaged 90º swivel fittings to allow for proper hose routing and not intrude on base vehicle parts.

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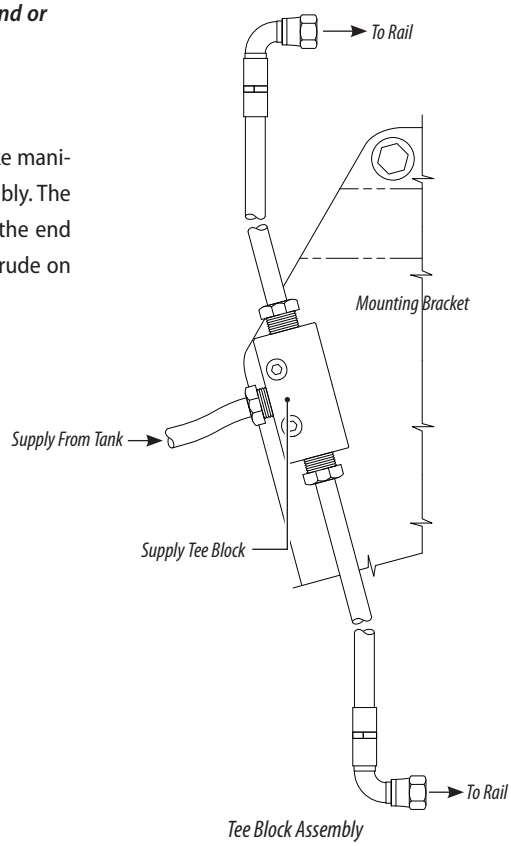
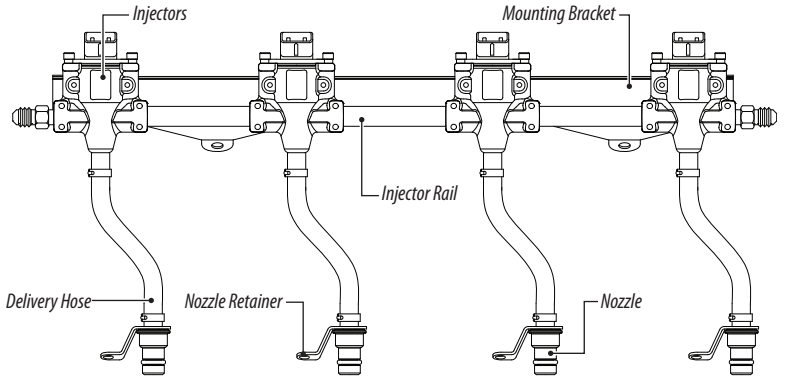


Tee Block Assembly

Fuel Rail Assemblies



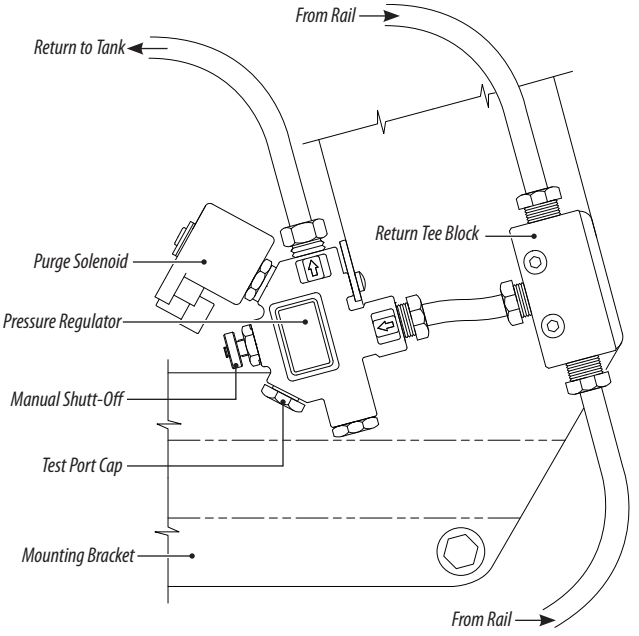
Injector Rail Assembly

Each fuel rail assembly is made up of four individual injectors fitted to the manifold by the means of a common mounting bracket. Each injector is mounted in a holder and each holder is connected via a brass tube connected with two securing pins at each holder The Fuel Rails are sealed to each holder with an o-ring. A flared fitting is installed at each end of the rail assembly to connect the fuel rails to the supply and return lines. The injector holder delivery hoses are fitted with a nozzle adapter and retainer. The nozzle is fitted to the manifold opening for each cylinder and is secured by the retainer to each manifold bolt.

The injectors are connected to the main harness with an Injector Harness assembly. Fuel delivery is accomplished the same as a gasoline injection system. A 12 volt power supply is delivered to each positive injector terminal and each individual injector negative terminal is connected to a pin at the engine PCM. Injectors are opened and closed by switching the ground internally in the PCM. Therefore fuel metering and fuel injection is controlled solely by the engines PCM. To diagnose electrical problems with the LPI fuel injectors refer to the Fuel Injector Diagnosis section of the GM Medium Duty Service Manual.

Fuel Pressure Regulator

The LPI fuel system pressure is regulated by an in-line pressure regulator mounted in the return line at the front of the engines intake manifold. Fuel is returned to the regulator via the Black return lines which are connected to a Tee block which is connected to the pressure regulator. The pressure regulator is preset at the factory and has been sealed to prevent infield alteration to the pressure setting. Fuel flow passing through the regulator has to overcome the flow resistance created by the regulator which increases fuel pressure. The regulator assembly is also fitted with a 12 volt purge solenoid which is opened during the purge cycle to allowing fuel to bypass the fuel pressure regulator valve during the purge cycle. The pressure regulator is also fitted with a test port which enables a test gauge to be installed to measure fuel system pressure.



Pressure Regulator Assembly

LPI Fuel Control Unit (FCU) and Electrical Harness

The Fuel Control Unit (FCU) is an electronic module that serves as a central control system for the LPI fuel system. The FCU controls the wait to start light, purge cycle and the automatic stop fill circuit. The FCU will interface with the engines electrical system and the buses electrical system. Although the FCU controls the fuel pump relay during the purge cycle thus providing fuel flow, the engine PCM provides the electrical signals to the injectors and therefore controls the fuel metering and injection of the liquid propane. The FCU provides control signals to the fuel supply solenoid, the purge solenoid, the fuel pump and purge cycle control systems.

The FCU is connected to the LPI system via the Main LPI Electrical harness. The LPI electrical harness also provides electrical interface between the LPI electrical system, the GM Vortec engine electrical system and the electrical system on the bus.

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Fuel System Pressure Release

During any fuel system maintenance or repair in which the fuel pressure must be released from the system use the following procedure.

WARNING ***LPG is under pressure, wear adequate eye protection. When LPG is discharged into the atmosphere the rapid change in pressure can cause a refrigerant condition in the fuel (quick cooling) and can harm your skin or cause serious burns much like frostbite, Always wear gloves.***

1. Close the manual supply valve on the multivalve (Turn Clockwise).See Multivalve Assembly.
2. Make sure the manual valve on the pressure regulator is fully closed.
3. Remove the test port cap located on the regulator. See Fuel Pressure Regulator.
4. Install the pressure test gauge tool with its manual valve closed and a drain hose attached (number CF-10001) to the test port on the pressure regulator.
5. Slowly open the manual valve on the pressure regulator.
6. Slowly open the manual valve on the pressure test gauge tool.
7. When the fuel flow stops at the discharge point on the drain hose the system pressure is released and you can safely work on the fuel supply/return lines, the injectors, the fuel pressure regulator or any associated external of the tank fuel system component. *DO NOTE REMOVE ANY PORTION OF THE MULTIVALVE OR ANY VALVE FROM THE TANK.* At this point all fuel pressure is isolated in the fuel tank.

WARNING ***When releasing the fuel pressure be sure to place the discharge point of the drain hose in a safe area free from any combustible material or ignition source. Be sure that no one is in the immediate area of the discharge hose.***

After fuel system service maintenance and/or repairs are complete, remove the pressure test gauge tool.

1. Close the manual valve on the pressure test gauge tool.
2. Close the manual valve on the pressure regulator.
3. Remove the test tool from the regulator.
4. Reinstall the test port cap and tighten.
5. Open the manual supply valve at the tank (Turn Counterclockwise).
6. Purge the fuel system *(Do Not Start the Engine)* Refer to Fuel System Purge Procedure below and repeat the procedure several times to fully purge the air out of the system.
7. Leak check the test port cap and all other connections loosened during the service procedure with an approved leak detection soap solution or electronic leak detector.

Fuel System Purge Procedure

After performing a Fuel System Pressure Release, air may enter the system through the open connections and/or ports. You will need to purge the fuel system a minimum of 3 purge cycles to expel all the air from the fuel rails and fuel lines. To purge the fuel system turn the ignition key to the Key On Engine Off (KOEO) position the wait-to-start light will illuminate for approximately 20 seconds (first stage of the purge cycle). See Fuel System Description and Operation at the beginning of this chapter for detailed operation of the purge cycle.

1. Make sure the battery is connected.
2. Check to make sure there is fuel in the tank.
3. Turn the key to the KOEO position.
4. Wait for the wait-to-start-light to go out.
5. Turn the key off and repeat steps 3 and 4 two additional times.
6. Turn the key back on (forth time), when the wait to start light goes out, start the engine; if the engine fails to start refer to the Fuel System Pressure Check procedure in this manual.

WARNING ***Technicians working with, or around, fuel systems should be properly trained to utilize extreme care and caution at all times. Failure to exercise extreme caution and care may lead to serious accidents which can result in property damage, personal injury and/or death.***

Fuel Tank Draining and Evacuation Procedure

The fuel tank on an LPI fuel system utilizes an electric fuel pump to deliver fuel to the injector fuel rails during normal operations. If you are removing the tank to service the Multivalve or to service in-tank components you must follow the procedures listed below.

WARNING ***Draining the LPI tank should be performed by a trained technician only. When draining a fuel tank use all the following precautions to prevent serious bodily injury, death and/or property damage.***

- ***Wear protective eye wear, gloves and clothing***
- ***Perform the process in a well ventilated area only***
- ***Remove all potential ignition sources from the area***
- ***Use only the recommended processes***
- ***Use the required tools***
- ***Drain the tank on the vehicle into a tank of equivalent or larger capacity***

WARNING ***Technicians working with, or around, fuel systems should be properly trained to utilize extreme care and caution at all times. Failure to exercise extreme caution and care may lead to serious accidents which can result in property damage, personal injury and/or death.***

Using In-Tank Pump

Use of the in-tank pump to drain the tank is an acceptable method, however, most of the components in the fuel tank must be functioning in their normal operation, specifically the pump. *NOTE: This method will not completely drain the tank and a final process of venting the tank will still be required. In some areas it is not allowed or may not be safe to vent the fuel to the atmosphere. In this case, the fuel must be burned off.*

1. Move the vehicle to a well ventilated area free of any external ignition sources.
2. Place the tank in which the fuel is to be captured close to the tank to be drained.
3. Remove the pressure in the fuel system using the Fuel System Pressure Release process.
4. Remove the green fuel supply line from the supply port at the supply solenoid on the multivalve.
5. Connect the fuel transfer hose to the supply port on the Multivalve using tool number CF-10002-LPI.
6. Connect the other end of the fuel transfer hose to the receiving tank fill valve or appropriate valve.
7. Remove the fuel pump relay and connect a switch/jumper harness assembly with the switch in the off position between terminals 30 and 87.
8. Open the manual supply valve on the tank to be drained and the valve on the capture tank.
9. Turn the switch on the jumper harness to the ON position, you should here the pump in the fuel tank running and fuel will begin to transfer to the capture fuel tank.

10. When the liquid propane level in the fuel tank drops below the fuel pumps pickup tube the pump will make a different sound. Turn the switch off to stop the pump.
11. The remaining fuel in the tank will now need to be evacuated through the liquid supply valve. In order to accomplish this the electrical portion of the liquid supply valve will require disassembly.
12. Close the supply valve on the Multivalve and the supply valve on the capture tank.
13. Loosen the fuel transfer hose and bleed off the fuel pressure.

WARNING ***Fuel may be under pressure in the transfer line; use caution when disconnecting the fittings, slowly loosen the fittings and use gloves and protective eye wear.***

14. Disconnect the transfer hose from the receiving tank and place the other end of the transfer hose in a safe, well ventilated location away from any area where the fuel could create a volatile condition.
15. Remove the liquid supply valve solenoid, remove the valve stem tower, remove the plunger and spring and re-install the valve stem tower. This allows the liquid supply valve to be controlled manually during servicing/ evacuating the fuel tank.
16. Make sure the fuel line at the multivalve is tight.
17. Slowly open the liquid supply valve and allow the tank to vent until the pressure has been released completely from the tank. It may be required to set up a flare stand to burn off the remaining fuel in the tank. This would require approximately a 50 foot clearance from the vehicle, other vehicles, a building or any combustible materials. Slowly open the valve on the flare stand and light the escaping gas; open the valve little by little to increase the time to evacuate. Most liquid supply valves are rated to pass 2.3 to 3.3 gallons per minute before the excess flow rating is exceeded and could close. If the excess flow closes during this operation simply close the liquid supply valve and re-open it slowly.

CAUTION ***Some states and municipalities may have regulations preventing the release of LPG into the atmosphere. Check with your local fire marshal or your local LPG supplier prior to venting or burning off a tank.***

18. When the pressure in the tank has reduced to a point that it does not support the flame turn the liquid supply valve off and disconnect the hoses. Open the liquid supply valve and vent the remaining pressure to the atmosphere.

WARNING ***Do not have any sources of ignition within a minimum of 50 foot of the area.***

19. Do not close the liquid supply valve after the pressure is completely released because pressure will build up in a closed tank even if the tank is empty. The pressure that would build up if the valve was closed would affect removing of any tank valve or component.
20. After service of the tank is complete and all components are replaced/re-installed replace the plunger and spring back into the liquid service valve stem tower and replace the solenoid.

NOTE: If you have any questions or concerns or you feel unqualified to perform the process of venting the tank contact you local fuel system provider or Clean Fuels USA at (877)-234-1722.

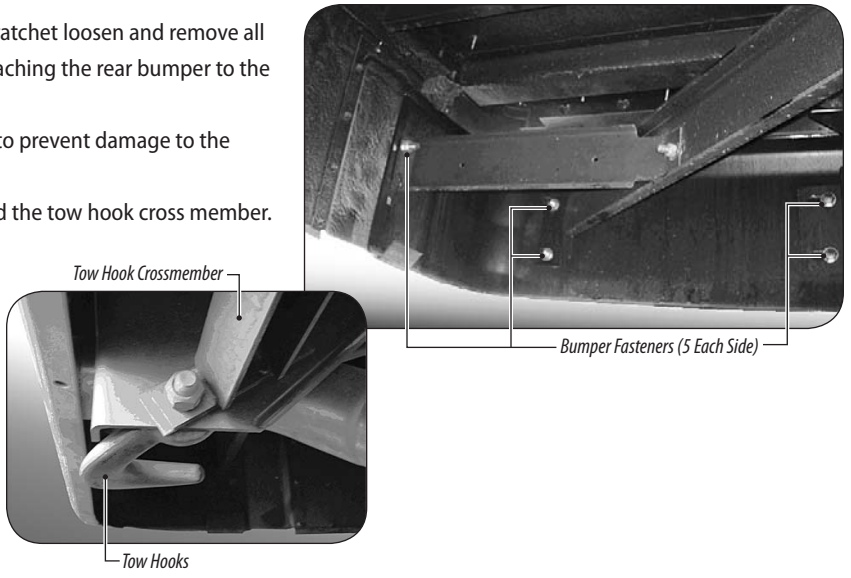
Fuel Tank Removal And Replacement

The cylindrical tank assembly for the LPI fuel system is mounted in the rear overhang between the frame rails parallel to the vehicle frame.

WARNING ***LPG Propane Gas is flammable. DO NOT vent propane in an enclosed area, or close to service pits, drainage ditches or low lying areas. DO NOT vent propane within 25 feet of any source of ignition, spark, open flame or heat. When venting propane liquid, it will vaporize at a very cold temperature (-44 F). Always wear safety goggles and gloves when handling systems venting gas. Always perform a complete system leak test after completing any service or maintenance.***

Removal

1. Be fully aware of the local regulations, NFPA codes and safety requirements for handling propane fuel prior to working on this unit.
2. Drain LPI fuel tank and purge of vapor in accordance with service manual safety instructions and warnings. See **Fuel Tank Draining & Evacuation Procedure**.
3. Leave supply valve, and 80% bleeder valve open for safety.
4. Carefully loosen the pressurized black and green lines located on the top front portion of the tank. Once the propane has been drained remove both lines. See **Propane Fuel System GM 8.1L**.
5. Remove black bleed hose from back of bleed valve on fuel neck assembly.
6. Remove the blue fill hose from back of the fill valve on the fuel neck assembly.
7. Using a wrench and/or socket ratchet loosen and remove all nuts and carriage fasteners attaching the rear bumper to the vehicle.
8. Carefully remove rear bumper to prevent damage to the vehicle.
9. Remove the rear tow hooks and the tow hook cross member.



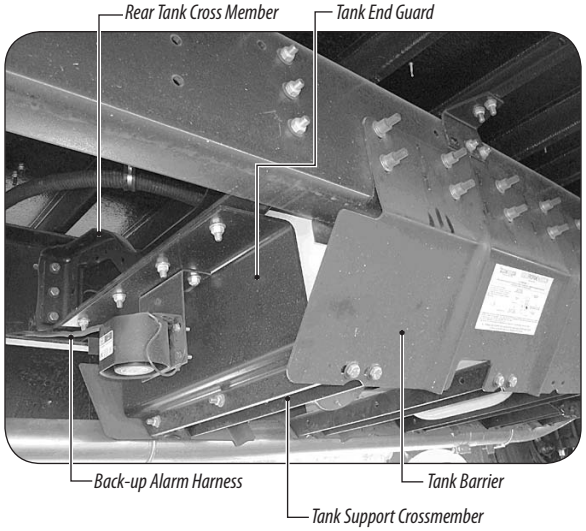
10. Detach back up alarm harness from vehicle frame and ensure it is safely out of the way.
11. Remove six fasteners attaching the rear tank cross member to the frame.
12. Remove four fasteners attaching the rear tank cross member to the tank end guard.
13. Remove three fasteners attaching the tank end guard to the tank support crossmember. Remove the tank end guard and rear tank cross member.
14. Unplug the tanks flat 6 pin connector from the vehicle harness located at the bottom center of the tank assembly. Cut any nylon ties that will prevent easy removal.
15. Remove 16 fasteners attaching the tank to the tank support cross members.
16. Remove every other nut and bolt attaching the tank support cross members to the right and left hand tank barriers.
17. Loosen but DO NOT remove remaining nuts and fasteners.
18. Using suitable lifting device (hydraulic table, transmission jack, etc) lift tank from tank support cross members approximately 1". *(Note: using 4x4 wooden blocks makes this much easier.)*

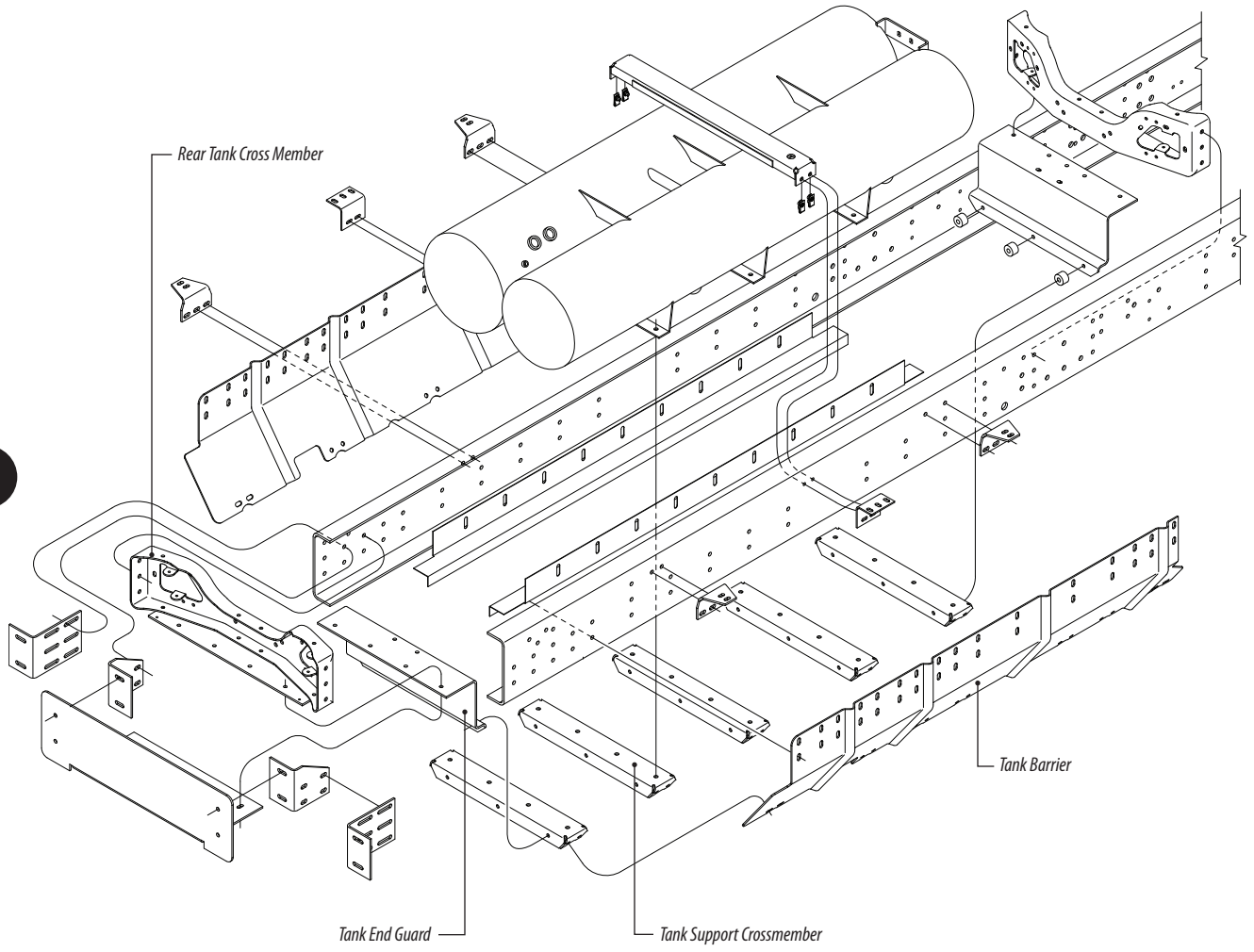
WARNING ***Ensure tank is securely fastened to lifting device to prevent accidental dropping.***

19. When tank is fully supported and stable on the lifting device, remove the four tank support cross members toward the rear of the vehicle. The forward most bracket doesn't need to be removed for this operation.
20. Center tank in the vehicle frame and roll lifting device toward rear of vehicle. Ensure the tank remains stable and centered as the lifting device is rolled rearward. Carefully feed the fill and bleed hoses over top of vehicle chassis into the middle of the chassis frame.

Replacement

Reverse the above procedure.





Fuel Tank & Barrier

Multivalve Removal and Replacement

CAUTION ***Be sure the tank has been completely drained before removing the multivalve from the tank. See Fuel Tank Draining Procedures.***

Service the tank or Multivalve in a well ventilated area and insure the tank is in a stable position prior to removing the Multivalve.

Removal

1. Disconnect the battery.
2. Drain the fuel tank, refer to Fuel Tank Draining Procedure.
3. Close the fuel supply line.
4. Disconnect the fuel supply line from the supply port at the Multivalve and move the line so it clears the fuel flange.
5. Disconnect the fuel fill line from the fill port at the Multivalve and move the line so it clears the fuel tank flange.
6. Disconnect the return line from the Multivalve and move the line so it clears the fuel tank flange.
7. Disconnect the LPI electrical harness connector, located at the bottom center of the fuel tanks and route the harness through the multivalve flange so it can be removed with the Multivalve.
8. Remove the ten (10) securing bolts from the Multivalve.
9. Lift the Multivalve from the tank. There will be several connections between in-tank components and the Multivalve restricting the distance the valve can be moved from the tank.
10. Using a Phillips screw driver remove the three screws retaining the electrical pass through harness and pull the harness through the multivalve.
11. Disconnect the electrical connector at the pressure switch.
12. Disconnect the electrical connector at the 80% stop fill solenoid.
13. Disconnect the 80% liquid level sensor harness.
14. Disconnect the electrical connector for the rheostat and float assembly.
15. Disconnect the fuel pump supply hose from the Multivalve.

CAUTION ***The fuel pump hose will have liquid fuel trapped inside. Use extreme caution. Disconnect slowly allowing the pressure to exit. Wear protective gloves.***

16. Disconnect the electrical connector at the fuel pump.
17. Disconnect the fuel return line.
18. Remove the Multivalve.

Replacement

1. Using a light weight petroleum jelly or o-ring lube, lightly lubricate a new o-ring on the Multivalve.
2. Place the Multivalve near the tank opening.

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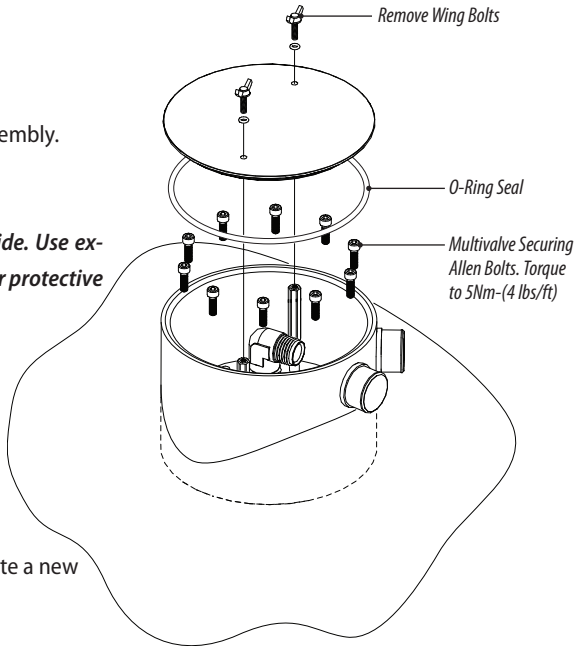


3. Connect the electrical circuit to the 80% stop fill solenoid.
4. Connect the electrical connector to the pressure switch.
5. Insert the five electrical connector into the Multivalve connection and secure with the one (1) retaining screw.
6. Reconnect the fuel pump hose to the Multivalve.
7. Position the Multivalve to the tank.
8. Install the ten (10) fasteners and tighten to specification; 5.0 Nm – (4 lbs ft)

80% Stop Fill Valve Service

Refer to Multivalve Assembly Diagram

Removal (Solenoid Only)

1. Drain the fuel tank, refer to Fuel Tank Draining Procedure.
2. Remove the multivalve assembly from the tank refer to Multivalve Removal.
3. Unplug the electrical connector.
4. Remove the Solenoid retaining nut.
5. Remove the Solenoid from the valve assembly stem.

Replacement (Solenoid Only)

1. Install the Solenoid to the valve assembly stem.
2. Install the nut and tighten until the nut is snug.
3. Connect the electrical connector, push the connector until it clicks, then pull on the connector to make sure it is locked. *NOTE: Solenoid will not be tight on the stem and is allowed to rotate freely.*
4. Reinstall the multivalve.

Removal (Valve Stem Only)

1. Drain the fuel tank, refer to Fuel Tank Draining Procedure.
2. Remove the multivalve assembly from the tank refer to Multivalve Removal.
3. Remove the solenoid retaining nut.
4. Remove the solenoid from the Valve Assembly Stem.
5. Remove the stem, valve spring and piston assembly.

Replacement (Valve Stem Only)

1. Lubricate the o-ring on the valve stem with a petroleum jelly.
2. Insert the piston into the 80% valve housing.
3. Insert the spring into the piston.
4. Insert the Valve Stem into the valve housing and tighten until snug.
5. Install the solenoid.
6. Install the solenoid retaining nut and tighten until snug.
7. Reinstall the multivalve

Removal (Valve Assembly)

1. Remove the multivalve assembly from the tank refer to Multivalve Removal.
2. Remove the solenoid retaining nut.
3. Remove the solenoid from the Valve Assembly stem.

4. Remove the Stop Fill Valve Assembly retaining screw.
5. Remove the valve assembly, spring and piston from the multivalve.

Replacement (Valve Assembly)

1. Install the piston into the multivalve.
2. Install the spring into the piston.
3. Install the Valve Assembly to the multivalve and secure with the retaining screws, tighten until the screws are snug.
4. Install the solenoid.
5. Install the solenoid retaining nut and tighten until snug.
6. Reinstall the multivalve.

Fill Pressure Switch Replacement

Refer to Multivale Assembly Diagram

Removal

1. Drain the fuel tank, refer to Fuel Tank Draining Procedure.
2. Remove the multivalve assembly from the tank refer to Multivalve Removal.
3. Remove the Pressure Sensor from the multivalve.
4. Disconnect the wire from the end of the sensor.

Replacement

1. Carefully install the sensor into the multivalve. *NOTE: Use caution when installing the pressure sensor as the threaded portion of the body is a plastic insert and can be damaged from cross threading or over tightening.*
2. Install the wire end lead onto the sensor.
3. Carefully tighten the sensor into the housing until the wire lead is snug at the base of the sensor Refer to pressure sensor replacement.
4. Reinstall the multivalve.

Fuel Pressure Relief Valve Replacement

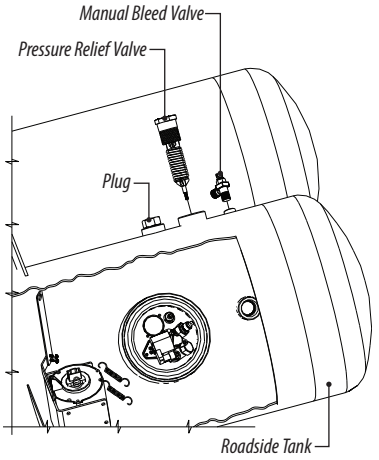
Removal

1. Drain the fuel pressure, refer to Drain The Fuel Tank procedures.

2. Disconnect the Fuel Pressure Relief Valve line.
3. Remove the Fuel Pressure Relief Valve.
4. Using a permanent marker, mark the location of the Relief Valve pickup tube to the fuel tank.
5. Remove the pick up tube.

Replacement

1. Install the Fuel Pressure Relief Valve into the threaded coupling and tighten. Use a pipe thread sealant suitable for liquid propane usage.
2. Reconnect the Fuel Pressure Relief Valve line.



Fuel Return Line Valve Replacement

CAUTION ***Be sure the tank has been completely drained before removing the return line manual shut off valve from the tank.***

Removal (Return Valve Only)

1. Drain the fuel tank, refer to Fuel Tank Draining Procedure.
2. Remove the Multivalve, refer to Multivalve removal procedure.
3. Remove the return hose from the return valve housings barb fitting.
4. Remove the return valve hose.
5. The return valve is a double back-check valve for redundancy & only one piston uses a spring, see photo insert.

Replacement (Return Valve Only)

1. Lubricate the valve seat with petroleum jelly.
2. Install the valve assembly and tighten until snug.

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Manual Shut Off Valve Replacement

CAUTION ***Be sure the tank has been completely drained before removing the manual shut off valve from the tank.***

Removal

1. Drain the fuel tank, refer to Fuel Tank Draining Procedure.
2. Remove the Manual Valve from the multivalve.

Replacement

1. Lubricate the valve seat with petroleum jelly.
2. Install the Manual Valve assembly and tighten until snug.

Multivalve Supply Flow Check Valve Replacement

Removal (Check Valve)

1. Drain the fuel tank, refer to Fuel Tank Draining Procedure.

2. Remove the multivalve assembly from the tank refer to Multivalve Removal.
3. Disconnect the fuel pump supply hose.
4. Remove the hose nipple from the multivalve adapter.
5. Remove the orifice, Check Valve and spring.
6. Remove the multivalve adapter and o-ring from the multivalve.

Replacement (Check Valve)

1. Lubricate the adapter o-ring and install to the adapter. Use lubricant approved for use with propane.
2. Install the adapter to the multivalve and tighten until snug.
3. Install the spring, Check Valve and orifice.
4. Install the nipple fitting to the adapter and tighten until snug.
5. Reconnect the fuel pump supply hose.
6. Reinstall the multivalve.

Fuel Pump/Filter Replacement *(In-Tank)*

Removal

1. Drain the fuel tank, refer to Fuel Tank Draining Procedure.
2. Remove the multivalve assembly from the tank refer to Multivalve Removal.
3. Reach into the tank and disconnect the Fuel Pump electrical connector.
4. Release the top spring retaining the Fuel Pump and holder.
5. Release the two lower retaining springs.
6. Lift the plastic pump and holder from the tank.
7. Slide the Fuel Pump from the filter.

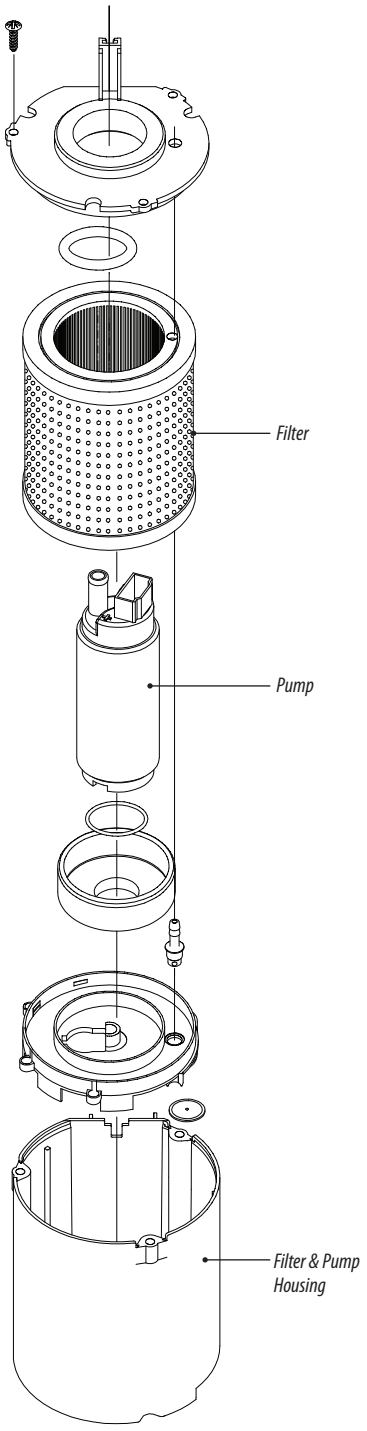
Replacement

1. Install the new pump into a new filter.
2. Insert the filter and pump into the plastic pump holder.
3. Install the Fuel Pump and holder into the tank in the pump mounting bracket.
4. Secure the pump holder with the two lower retaining springs and the one upper retaining spring.
5. Connect the fuel pump electrical connector.
6. Reinstall the multivalve.

Rheostat Replacement *(In-Tank)*

Removal

1. Drain the fuel tank, refer to Fuel Tank Draining Procedure.

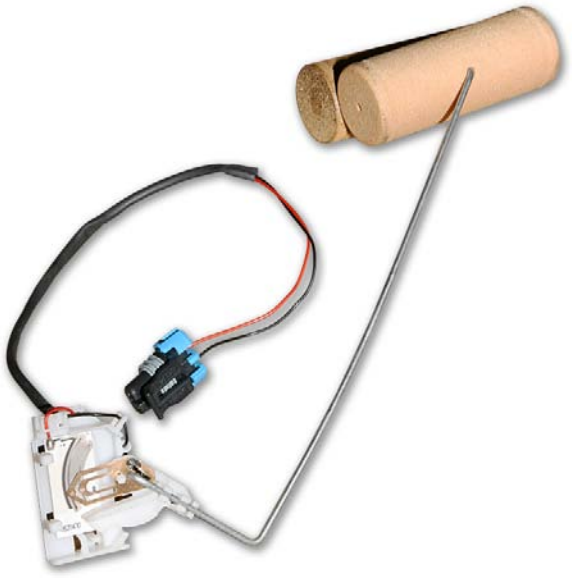


Fuel Punmp and Filter

2. Remove the multivalve assembly from the tank refer to Multivalve Removal.
3. Reach into the tank and disconnect the electrical connector at the Rheostat.
4. Remove the two (2) retaining nuts from the float and Rheostat mounting. bracket.
5. Remove the float assembly and Rheostat.
6. Remove the plastic rheostat cover from the Rheostat.

Replacement

1. Install the rheostat cover onto the new Reostat and bracket.
2. Install the new Rheostat onto the two mounting studs.
3. Install the float assembly onto the two mounting studs and secure using the two (2) nuts.
4. Tighten nuts until snug.
5. Connect the Rheostat electrical connector.
6. Reinstall the multivalve.



Rheostat and Float Assembly

Float Assembly Replacement *(In-Tank)*

Removal

1. Drain the fuel tank, refer to Fuel Tank Draining Procedure.
2. Remove the multivalve assembly from the tank refer to Multivalve Removal.
3. Reach into the tank and disconnect the Float Assembly electrical connector.
4. Remove the two (2) retaining nuts from the float and rheostat mounting bracket.
5. Remove the Float assembly.

Replacement

1. Install the Float assembly onto the two mounting stud and secure using the two (2) nuts.
2. Tighten nuts until snug.
3. Connect the Float assembly electrical connector.
4. Reinstall the multivalve.

Remote Mounted Fuel Fill Valve Replacement

The LPI fuel system on this vehicle utilizes a remote mounted fill valve location. The fill valve is located on the curb side of the vehicle and is attached by a fuel fill hose to the multivalve.

Removal

1. Drain the fuel tank refer to Tank Draining Procedure.
2. Locate the remote mounted Fill valve.
3. Remove the Fill Valve from the remote mounted fixture.

Replacement

1. Apply a liquid type pipe sealant to the remote mounted fixture.
2. Install the Fill Valve to remote mounted fixture.
3. Tighten until sealed.
4. Fill tank and leak check the fitting using an approved leak detection soap solution or a electronic leak detector.

Remote Fuel Fill Line Replacement

This vehicle utilizes a remote fill device mounted in the curbside side panel. The fill valve will be mounted to a bracket and a fuel line will be connected from the fill valve to the tank multivalve. To replace the remote line use the following steps.

Removal

1. Disconnect the battery.
2. Remove any securing clamps or devices.
3. Slowly loosen the hose at the fill and drain the fill line. The fill valve is a double back check valve and only allows fuel flow in one direction. The fill hose will drain complete not allowing any fuel from the tank to escape. It may take a minute or two to drain this hose.
4. Loosen the fill line at the Multivalve connector and remove the line.

Replacement

1. Install the remote fill line at the Multivalve and tighten until fully sealed. *NOTE: No sealant required on flare or compression fittings, ONLY on pipe threads where applicable.*
2. Connect the line at the fill valve and tighten until fully sealed.
3. Connect the fill valve to a fuel source and charge the line.
4. Leak check all fittings.
5. Secure the fuel line using the originally installed clamps.

Fuel Supply And Return Line Replacement

The fuel supply and return lines are made of special material and should only be replaced or repaired using original equipment parts. The fuel line can be removed using the following procedure.

Removal (Fuel Line)

1. Remove any securing clamps or ties from the hose(deletion).
2. Release the pressure in the system by using the Fuel System Pressure Release procedure.
3. Slowly loosen the fittings at each end of the hose.

WARNING ***LPG is under pressure, wear adequate eye protection. When LPG is discharged into the atmosphere the rapid change in pressure can cause a refrigerant condition in the fuel and can harm your skin or cause serious burns, always wear gloves.***

4. Remove the hose to be repaired.

Replacement (Fuel Line)

1. Reinstall the hose.
2. Tighten the hose ends until fully seated and tight.

Compression Fitting Replacement

Certain hoses are made with a fixed swaged hose connector at one end and a compression fitting at the opposite end. The compression fitting can be repaired or replaced using the following procedure. *NOTE: Certain hoses are installed with a spring guard to prevent kinking and collapsing of the hose. If you shorten the hose you may need to retain the spring guard and reinstall after shortening the hose.*

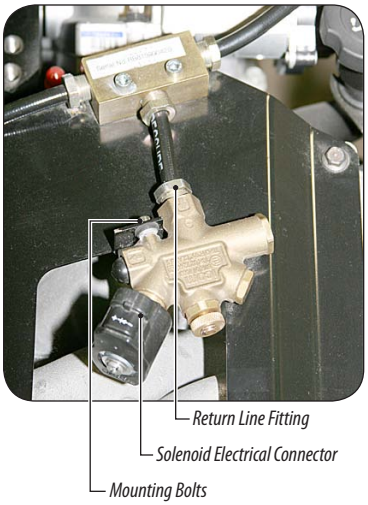
1. Using a hose cutting tool cut the hose end from the hose.
2. Discard the hose end.
3. Slide the compression nut onto the hose.
4. Slide the new Collet onto the hose. *NOTE: Make sure the long tapered edge is facing the nut.*
5. Install the Farrell onto the end of the hose until it is fully seated.
6. Slide the Collet down to the Farrell. Install the Compression tool over the hose so that the recessed edge of the clamping tool is against the tapered edge of the Collet.
7. Place the coned shaped end of the compressing screw into the end of the Farrell.
8. Start turning the Tee handle until the Collet is seated against the edge of the Farrell.
9. Remove the tool.
10. Reinstall the hose, refer to Fuel Supply and Return Line Replacement.

WARNING ***Technicians working with, or around, fuel systems should be properly trained to utilize extreme care and caution at all times. Failure to exercise extreme caution and care may lead to serious accidents which can result in property damage, personal injury and/or death.***

Fuel Pressure Regulator Replacement

When replacing the fuel pressure regulator use the following procedure.

Fuel Pressure Regulator



Removal

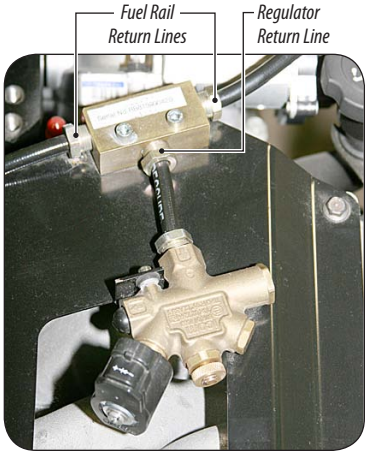
1. Close the manual supply valve at the multivalve.
2. Relieve the pressure in the system, refer to Fuel System Pressure Release.
3. Disconnect the purge solenoid electrical connector.
4. Disconnect the return line at the regulator fitting.
5. Loosen the return line hose from the Tee block to the regulator at the regulator.
6. Remove the two (2) regulator mounting bolts and retain.
7. Remove the one (1) regulator return line fitting and retain.

Replacement

1. Install in the new regulator and tighten until fully seated.
2. Install the regulator to the mounting bracket using the two (2) previously removed mounting screws.
3. Tighten fasteners until fully tight.
4. Install the return line hose from the Tee block to the regulator and tighten the nut until fully seated.
5. Connect the Return line to the regulator return line fitting and tighten until fully seated.
6. Connect the Purge Solenoid electrical connector. *NOTE: Push until you hear a click then pull to insure the connector is locked.*
7. Open the supply manual valve at the Multivalve until they are fully open.
8. Purge the fuel system by turning the key to the KOEO position and wait until the light in the dash goes out.
9. Repeat the purge process several times.
10. Leak check all fuel fittings using an approve leak detection soap solution or an electronic leak detector

Injector Return Line Tee Block Replacement

When replacing the Injector Return Line Tee Block use the following procedure.



Return Tee Block

Removal

1. Close the manual supply valve at the multivalve.
2. Relieve the pressure in the system, refer to Fuel System Pressure Release.
3. Disconnect both the fuel rail return lines from the Tee block.
4. Loosen the return line hose from the Tee block to the regulator at the Tee block.
5. Remove the two (2) Injector Return Line Tee Block retaining bolts and nuts and retain.
6. Remove the Injector Return Line Tee Block.

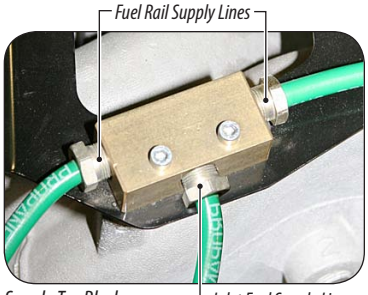
Replacement

NOTE: Do not use liquid pipe sealant on the compression fitting connections. Always check the compression fittings for damage before reinstalling.

1. Install the new Injector Return Line Tee Block to the bracket secure it using the two (2) retaining bolts and nuts.
2. Tighten until fully secured.
3. Install the return line hose from the Tee block to the regulator at the Tee block and tighten until fully seated.
4. Install both the fuel rail return lines to the Tee block tighten until fully seated.
5. Open the manual supply valve at the multivalve until they are fully open.
6. Purge the fuel system by turning the key to the KOEO position and wait until the light "Wait to Start" light on the dash goes out.
7. Repeat the purge process several times.
8. Leak check all fuel fittings using an approved leak detection soap solution or a electronic leak detector.

Fuel Supply Tee Block Replacement

When replacing the Forward Fuel Supply Tee Block use the following procedure.



Removal

1. Close the manual supply valve at the multivalve.
2. Relieve the pressure in the system, refer to Fuel System Pressure Release.
3. Disconnect both the fuel rail supply lines from the Tee block and cap both fittings.
4. Disconnect the inlet fuel supply line from the Tee block.
5. Remove the inlet fuel supply fitting from the Tee block.
6. Remove the two (2) Tee Block retaining bolts and nuts and retain.
7. Remove the Tee Block.

Replacement

NOTE: Do not use liquid pipe sealant on the compression fitting connections. Always check the compression fittings for damage before reinstalling.

1. Install the new Tee Block to the bracket secure the tee using the two (2) bolts and nuts.
2. Install the fitting into the Tee block and tighten until fully seated.
3. Connect the fuel supply line to the inlet fitting and tighten until fully seated.
4. Install both the fuel rail supply lines to the Tee block and tighten until fully seated.
5. Open the manual supply valve at the multivalve until they are fully open.
6. Purge the fuel system by turning the key to the KOEO position and wait until the "Wait to Start" light on the dash goes out.
7. Repeat the purge process several times.
8. Leak check all fuel fittings using an approved leak detection soap solution or a electronic leak detector.

Fuel Rail Replacement

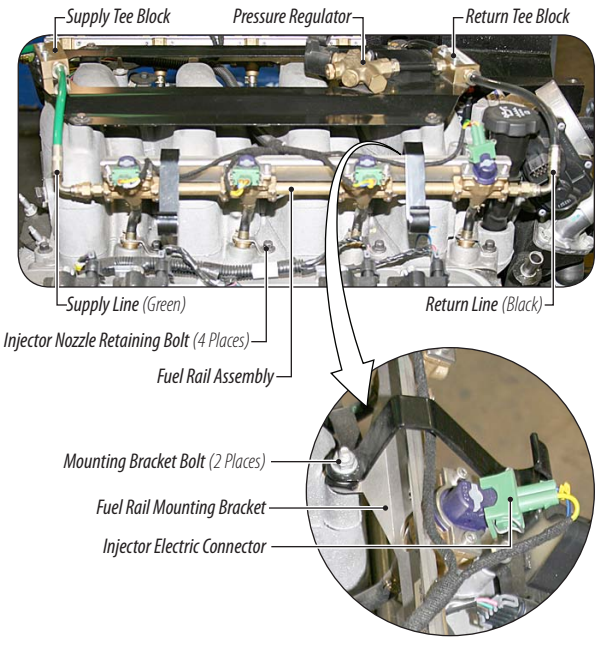
***CAUTION** When removing or replacing any fuel delivery components which include: Fuel Rails, Injectors, or Supply Lines, thoroughly clean the work area with solvents and compressed air to remove any debris or contaminants. Always insure your hands are clean when handling fuel injection components to prevent contaminating the fuel delivery systems.*

***CAUTION** Contamination may cause the injectors to stick, leak, or become damaged, delivering incorrect amounts of fuel and causing the fuel control system to be non-compliant. NOTE: Always cap any open ports after disconnecting fuel lines, removing injectors or the fuel rails to prevent contamination of the fuel delivery system.*

When removing the fuel rails use the following procedure.

Removal

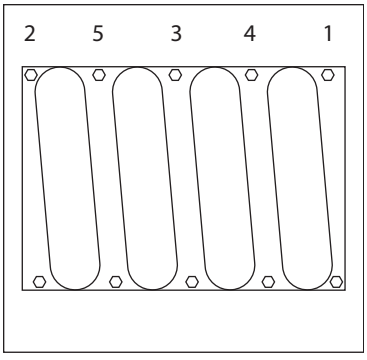
1. Close the manual supply valve at the multivalve.
2. Relieve the pressure in the system, refer to Fuel System Pressure Release.
3. Disconnect both the fuel rail supply line and return line from the fuel rail fittings and cap both the fittings and the hose ends. *NOTE: Use a backup wrench on the fuel rail fitting when disconnecting the fuel supply and return line connections.*
4. Tag each injector connector to insure that the correct connector is re-installed properly.
5. Disconnect each of the injector electrical connectors.
6. Remove the two (2) fuel injector bracket retaining bolts at the manifold and retain.
7. Remove the four (4) fuel injector nozzle retaining bolts (Manifold Bolts) and retain.
8. Lift the Fuel Rail from the intake manifold and cap all nozzles and place protective covering over each of the open manifold holes.



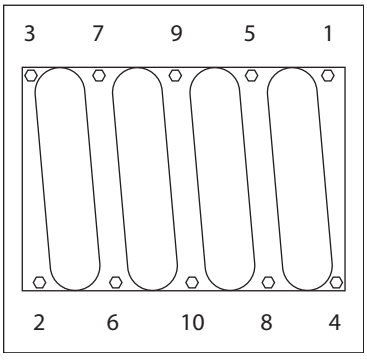
Curbside Fuel Rail

Replacement

1. Using a petroleum jelly or an o-ring lube lightly coat each nozzle o-ring.
2. Place the Fuel Rail assembly onto the intake manifold.
3. Starting at the rear remove the nozzle cap and the manifold plug and install the nozzle into the hole.
4. Rotate the nozzle retainer over the manifold bolt hole and install a manifold retaining bolt hand tighten the bolt.
5. Continue to install the balance of the nozzles into the manifold.
6. Tighten the Fuel Rail to specification; 15 Nm (11 lbs ft.), using the tightening sequence shown.
7. Position the Fuel Rail bracket onto the manifold and secure using the two (2) previously removed bolts.
8. Tighten the bolts until secured.
9. Check the electrical tag and connect each injector electrical connector to the proper injector.
10. Reinstall the fuel rail supply and return lines.

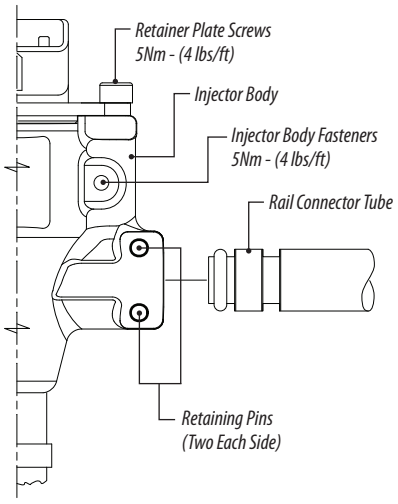


Single Rail Removal Tightenting Sequence



Both Rails Removed Tightenting Sequence

Fuel Injector Assembly Replacement



CAUTION ***When removing or replacing any fuel delivery components which include: Fuel Rails, Injectors, or Supply Lines, thoroughly clean the work area with solvents and compressed air to remove any debris or contaminants. Always insure your hands are clean when handling fuel injection components to prevent contaminating the fuel delivery systems.***

If a single injector must be replaced use the following procedure. *NOTE: The injector body itself is almost never disassembled, only the injector is replaced. To replace an injector you do not need to pull the complete rail assembly.*

Removal

1. Remove the injector rail assembly refer to Fuel Rail Replacement.
2. Remove the fuel rail bracket by removing the eight (8) retaining screws.
3. Place the fuel rail assembly on a clean work surface.
4. Place a small block of wood under the injector to be replaced.
5. Using a small hammer and punch, drive the four (4) retaining pins out of the injector body and retain the pins.
6. Pull the connector tubes from each side of the injector body.
7. Cap all open ports on the fuel rail and Injectors.

Replacement

NOTE: Before removing the injector assembly from the package, clean the work area and your hands. Do not remove the protective caps until it is necessary.

1. Remove the protective caps from one of the connector tubes and lightly lubricate the o-ring with a petroleum jelly or o-ring lube.
2. Remove the injector assembly from the plastic bag.
3. Position the injector assembly in the correct position (All injector wire connectors facing the same way).
4. Remove one protective cap and install the previously lubed connector tube into the injector body.
5. Press two (2) pins into the body.
6. Place the injector assembly on a small block of wood and drive the pin into place using a small hammer.
7. Drive the pin in until the head is against the injector housing.
8. Repeat steps 1, 3, 4, 5, 6 & 7.
9. Mount the injector rail to the rail mounting bracket using the eight (8) screws and tighten until fully seated.
10. Reinstall the fuel rail assembly refer to Fuel Rail Replacement.

Fuel Injector Replacement

NOTE: It is possible to service the injector on the vehicle. However clean the area thoroughly with an acceptable engine cleaner and blow the area clean with compressed air before starting.

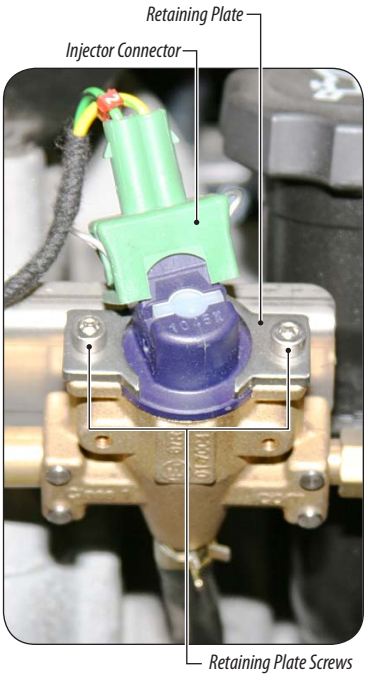
CAUTION ***When removing or replacing any fuel delivery components which include: Fuel Rails, Injectors, or Supply Lines, thoroughly clean the work area with solvents and compressed air to remove any debris or contaminants. Always insure your hands are clean when handling fuel injection components to prevent contaminating the fuel delivery systems.***

CAUTION ***The Injector, Calibrator, and the Calibrator Holder are a matched set and must be replaced as a kit. If removing multiple injectors keep each set of injectors and calibrators together as a set and replace in the same injector body.***

If replacing one or more injectors use the following procedure.

Removal

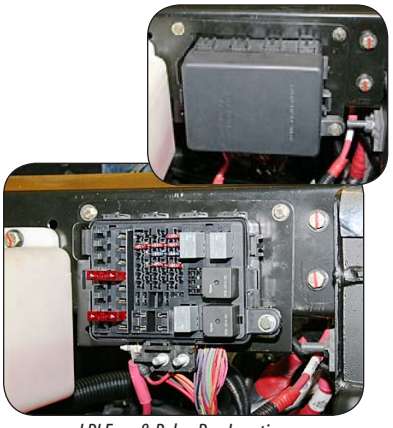
1. Close the manual supply valve at the Multivalve.
2. Relieve the pressure in the system, refer to Fuel System Pressure Release.
3. If replacing more than one injector, tag the injector connectors to insure the correct connectors are reinstalled.
4. Remove the two (2) injector retaining plate screws and retain.
5. Remove the retaining plate.
6. Using a small screw driver place it between the plastic edge of the injector and the brass body.
7. Rotate the screw driver slowly this will allow the injector to rise against the resistance of the sealing o-ring.
8. Slowly lift the injector out of the holder. *NOTE: The calibrator and holder may be attached to the injector when removing and could drop into the engine compartment.*
9. Using needle nose pliers or clamping forceps reach into the holder and remove the calibrator and holder.
10. Using a pick remove the calibrator seal from the body.
11. Using a lint free cloth and denatured alcohol clean the bore of the holder.



Replacement

NOTE: Before removing the injector assembly from the package, clean the work area and your hands. Do not remove the protective caps until it is necessary.

1. Place the calibrator seal into the bore of the holder and insure the seal is in place and fully seated.
2. Use a mirror to check the seal position.
3. Place the calibrator into the holder with the o-ring end of the calibrator facing up.
4. Using reverse locking ring pliers, clamp the holder and lower the holder and calibrator into the bore.
5. Using a mirror check to insure the calibrator and holder are properly positioned in the bore.
6. Remove the protective cap from the injector and lightly lubricate the upper and lower sealing o-rings.
7. Place the injector into the holder and press down.
8. Rotate the injector electrical connector into the proper position.
9. Install the retaining plate.
10. Install the two (2) retaining screws and draw the injector down until it is full seated and the injector screw are tight.
11. Connect the injector electrical connectors.
12. Open the manual supply valve at the multivalve.
13. Purge the fuel system.
14. Leak check the rail using an approved leak detection soap solution or electronic leak detector.



LPI Fuse & Relay Box Location

LPI Fuel Control Unit Replacement

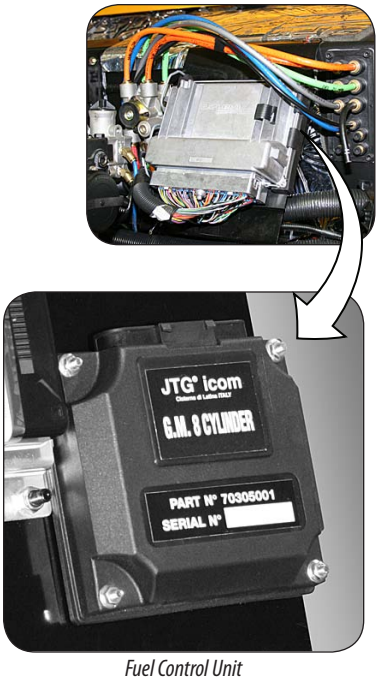
The LPI fuel system utilizes a Fuel Control Unit (FCU). It interrupts the ground signal to the original fuel pump control relay to control the purge timing and the wait to start indicator. It also controls the tank overfill prevention circuit. To replace the FCU use the following procedure.

Removal

1. Disconnect the main harness connector at the FCU.
2. Remove the four (4) mounting screws and nuts and retain.
3. Remove the FCU.

Replacement

1. Install the FCU to the mounting bracket using the four (4) screws and nuts and tighten until fully secured.
2. Reconnect the main harness connector to the FCU.
3. Push until you hear the click then pull on the connector to insure the connector is locked.



Fuel Control Unit

Maintenance of the LPI Fuel System

This section covers the items in the LPI fuel system, which requires regularly scheduled maintenance. For maintenance of the base engine refer to the GM Medium Duty Service Manual or consult your GM dealer Service Department.

Fuel Tank Maintanance

The fuel tank equipped has been certified to ASME Tank and Pressure vessel requirements and the installation complies with all NFPA Pamphlet 58 Standards in affect at the time of certification. State and or local regulatory agencies may require a periodic inspection of the LPG tank. At a minimum of every 12 months the LPG tank should be inspected by a trained technician for the following items:

- Check for impact damage, dents, cuts or severe gouging or any tank deformation
- Check for rust and paint flaking
- Check for cracks in the welded seams or mounting brackets
- Check to insure the service valves or shut off valves are functioning and manually closes the valve
- Check to insure the pressure relief valve vent is clear of any obstructions and is properly orientated
- Check all electrical connections to insure they are properly seated and have not become corroded
- Check all mounting fasteners and brackets to insure the tank is properly fitted to the chassis
- Leak check all external fittings and connection

If during the tank inspection any or all the above have been observed you should have the tank repaired by a certified LPG Tank Repair Facility or replace the tank.

WARNING ***Never cut or weld on the LPG fuel tank. Repairs to the fuel tank should only be made by a certified LPG tank repair facility. Failure to observe this warning could result in serious bodily injury, death and/or serious property damage.***

Fuel Filter Maintenance

The LPG fuel pump is located inside the LPG tank. The pump is equipped with a filter which requires periodic service.

It is recommended that the fuel filter be replaced every 60,000 Miles (96,550km) or 24 months which ever occurs first Refer to the Fuel Filter Replacement procedure in this manual.

Fuel Supply And Return Line Maintenance

The fuel supply and return lines are made of special thermoplastic material. It is recommended that the fuel line connections be leak checked annually or anytime the lines have been removed. The routing of the lines should also be inspected annually to insure that the lines have not come into contact with any rotating devices, hot surfaces, or are located in a position in which they may be impacted by road debris.

Fuel Pressure Regulator

The fuel pressure regulator does not require any periodic adjustment. You should annually inspect the following items on the fuel pressure regulator:

- Check to make sure the mounting bracket is securely fastened and there is no cracking or breaking in the bracket
- Check to make sure the regulator is securely attached to the bracket
- Check to make sure the electrical lock-off connector is securely attached and that the wiring is secured
- Leak check the fuel line connector using an electronic leak detector or an approved leak detection soap solution

Fuel Rails And Injectors

The fuel rails and injectors require no periodic adjustment. You should annually inspect the following items on the fuel rails and injectors:

- Check to make sure the rail brackets are securely attached to the manifold
- Check to make sure the rail bracket have no cracking or breaking
- Check to make sure that each injector is securely attached to the rail bracket
- Leak check all the connections on the fuel rail at each injector connector and the inlet and outlet fitting at the rail using an electronic leak detector or an approved leak detection soap solution
- Check the injector delivery hose for any cracking, kinky, cuts, or deformation, replace if necessary
- With the engine running use an electronic leak detector or an approved leak detection soap solution to check the delivery nozzle to intake manifold and all hose connections for leaks

Electrical System Checks

The electrical system, wiring harness, fuel control unit (FCU) do not require any periodic adjustments. You should annually inspect the following items:

- Check the mounting bracket for the fuel control unit (FCU) for cracks or breaking
- Check the controller mounting bracket securing bolts to insure they are securely fastened
- Check the electrical connector and insure the connector is securely attached, locked and the secondary lock is in position
- Check the wire harness routing under the hood to insure the main harness and injector harness have not come into contact with any rotating devices, hot surfaces, or have come loose from their securing points and are hanging in an unsafe location.
- Check all electrical connectors by lightly pulling on each connector to insure the connector is fully locked and seated
- Check all wire ties used to secure the harness for cracking, splitting, or breakage, replace if necessary
- Check the harness routing to the fuel tank connector and insure the harness is securely attached to the frame and protected from any hot surfaces, rotating devices or road debris,repair any unsafe condition

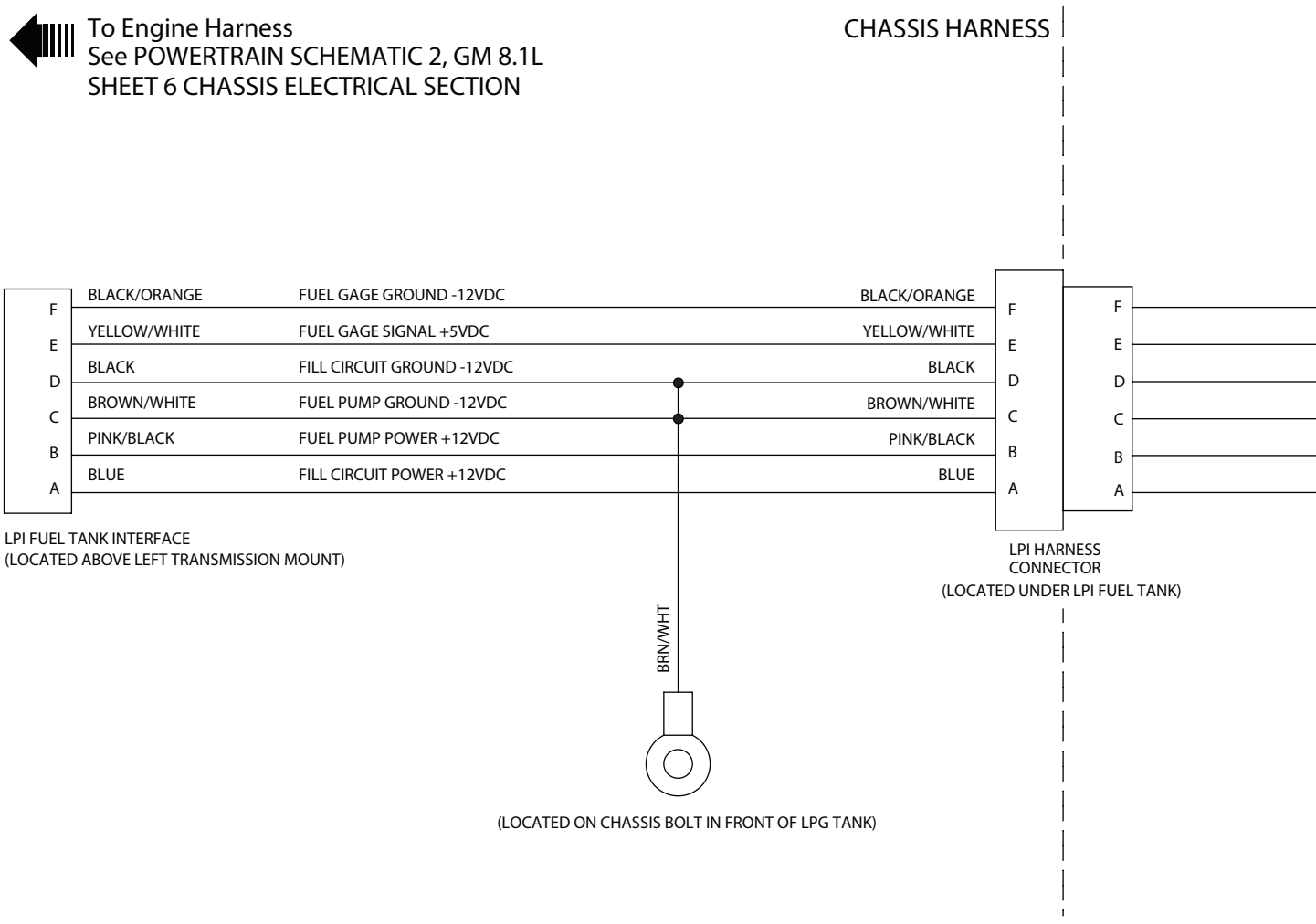
LPI Maintenance Schedule

LPI FUEL SYSTEM RECOMMENDED MAINTENANCE SCHEDULE

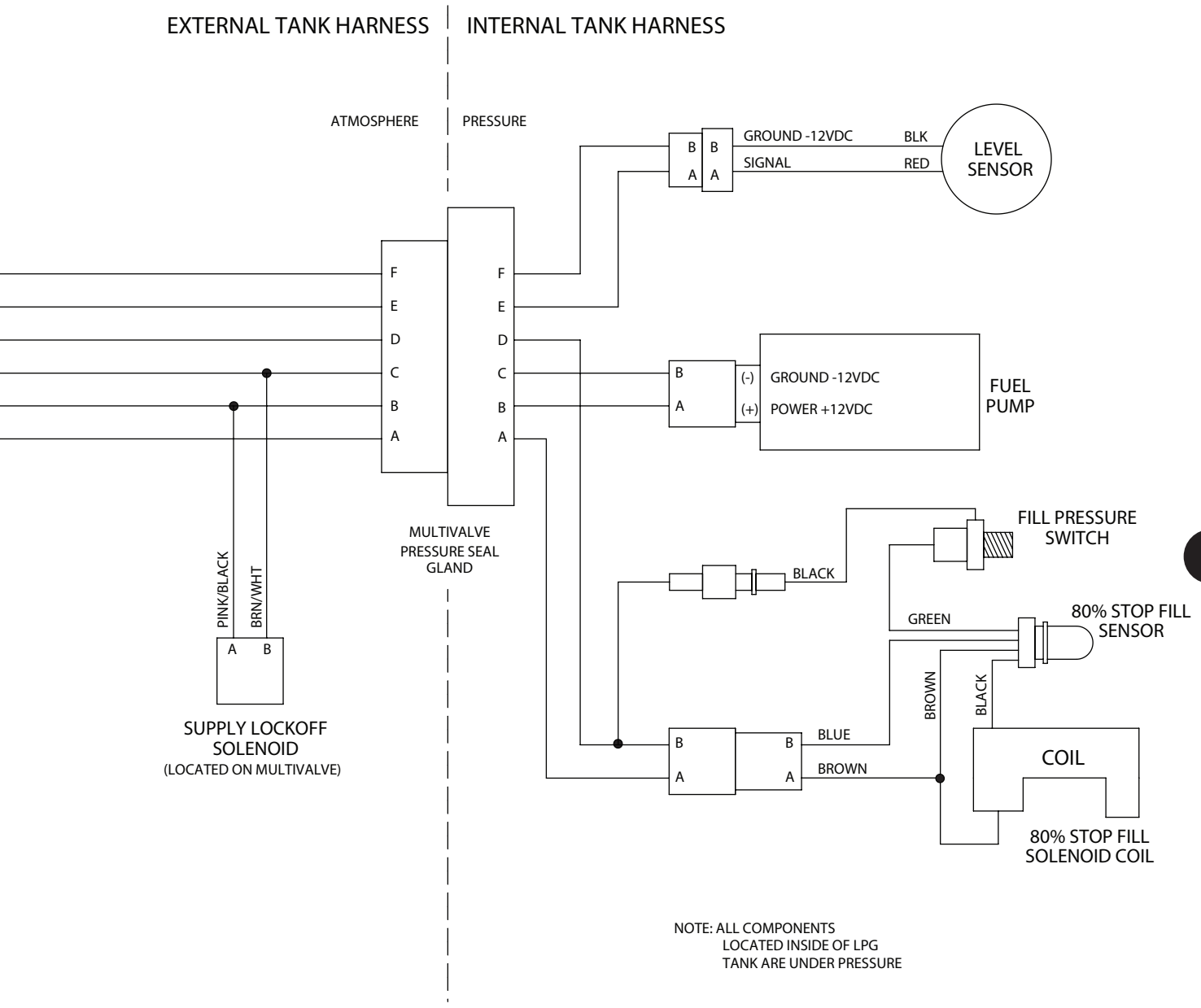
DESCRIPTION OF MAINTENANCE	FREQUENCY					
	ANNUALLY	OR	30,000 MILES	60,000 MILES	90,000 MILES	120,000 MILES
Fuel Tank Inspections						
Check for rust, dents, or external impact damage	X				X	
Leak check all tank fittings and connections	X		X	X	X	X
Check all tank retaining devices	X				X	
Fuel Filter replacement				X		X
Fuel Supply and Return Lines						
Check line routing check securing points	X				X	
Inspect lines for damage	X				X	
Fuel Pressure Regulator						
Mounting bracket securely attached	X				X	
Regulator securely attached to bracket	X				X	
Leak check all connections	X		X	X	X	X
Check electrical connectors	X				X	
Fuel Rail and Injectors						
Rail bracket securely attached	X				X	
Injectors securely attached to rail bracket	X				X	
External leak check injectors	X		X	X	X	X
Injector Hose inspection	X				X	
Electrical System Inspection						
Check controller mounting bracket	X				X	
Check controller for damage	X				X	
Check controller connection	X				X	
Check under hood wire harness routing	X				X	
Check under hood wire harness connections	X				X	
Check underbody wire harness routing	X				X	
Check fuel tank wire harness connections	X				X	
Spark Plugs and Wiring						
Check Spark plug gap and condition				X		
Check Spark Plug wiring				X		
Replace Spark Plugs					X	

This maintenance schedule represents Clean Fuels USA recommended maintenance intervals to insure safe & reliable operation of the *LPI* fuel system. Specific state and federal regulation may require vehicle operators to perform more comprehensive or frequent inspections. If you have any questions regarding the maintenance procedures and or question regarding the system please contact Clean Fuels USA.

LPI Wiring Schematic



LPI Wiring Schematic



NOTE: ALL COMPONENTS
LOCATED INSIDE OF LPG
TANK ARE UNDER PRESSURE

LIQUIDPROPANEINJECTION
SYMTOMS DIAGNOSTIC CHARTS

Table of Contents

LPI LIQUIDPROPANEINJECTION

SYMTOMS DIAGNOSTIC CHARTS

Important Preliminary Checks

Checks	Action
Before Using This Section	Before using this section, you should have performed On Board Diagnostic Check and determined that: 1. The FCU (Flow Control Unit) and MIL (Malfunction Indicator Lamp) are operating correctly. 2. There are no Diagnostic Trouble Codes (DTCs) stored, or a DTC exists but without a MIL. Several of the following symptom procedures call for a careful visual and physical check. The visual and physical checks are very important. The checks can lead to correcting a problem without further checks that may save valuable time.
LPG Fuel System Check	1. Verify the customer complaint. 2. Locate the correct symptom table. 3. Check the items indicated under that symptom. 4. Operate the vehicle under the conditions the symptom occurs. Verify HEGO switching between lean and rich. **IMPORTANT!** **Normal HEGO switching indicates the LPG fuel system is in closed loop and operating correctly at that time.** 5. If a scan tool is available, **take a snapshot** under the condition that the symptom occurs. Go to *Engine Scan Tool Data* List to verify normal sensor values and parameters.
Visual and Physical Checks	• Check all PCM system fuses and circuit breakers. • Check the PCM ground for being clean, tight and in its proper location. • Check the vacuum hoses for splits, kinks and proper connections. • Check thoroughly for any type of leak or restriction. • Check for air leaks at all the mounting areas of the intake manifold sealing surfaces. • Check the ignition wires for the following conditions: – Cracking – Hardness – Proper routing – Carbon tracking • Check the wiring for the following items: – Proper connections, pinches or cuts. • The following symptom tables contain groups of possible causes for each symptom. The order of these procedures is not important. If the scan tool readings do not indicate the problems, then proceed in a logical order, easiest to check or most likely to cause first.

LPI LIQUIDPROPANEINJECTION

SYMTOMS DIAGNOSTIC CHARTS

Intermittent

Checks	Action
DEFINITION: The problem may or may not turn ON the Malfunction Indicator Lamp (MIL) or store a Diagnostic Trouble Code (DTC).	
Preliminary Checks	• Refer to *Important Preliminary Checks.* • Do not use the DTC tables. If a fault is an intermittent, the use of the DTC tables may result in the replacement of good parts.
Faulty Electrical Connections or Wiring	• Faulty electrical connections or wiring can cause most intermittent problems. • Check the suspected circuit for the following conditions: – Faulty fuse or circuit breaker – Connectors poorly mated – Terminals not fully seated in the connector (backed out) – Terminals not properly formed or damaged – Terminal to wires poorly connected – Terminal tension insufficient. • Carefully remove all the connector terminals in the problem circuit in order to ensure the proper contact tension. If necessary, replace all the connector terminals in the problem circuit in order to ensure the proper contact tension. • Checking for poor terminal to wire connections requires removing the terminal from the connector body.
Operational Test	If a visual and physical check does not locate the cause of the problem, drive the vehicle with a scan tool. When the problem occurs, an abnormal voltage or scan reading indicates the problem may be in that circuit.
Intermittent Malfunction Indicator Lamp (MIL)	The following components can cause intermittent MIL and no DTC(s): • A defective relay, Control Module driven solenoid, or a switch that can cause electrical system interference. Normally, the problem will occur when the faulty component is operating. • The improper installation of electrical devices, such as lights, 2-way radios, electric motors, etc. • The ignition secondary voltage shorted to a ground. • The Malfunction Indicator Lamp (MIL) circuit or the Diagnostic Test Terminal intermittently shorted to ground. • The Control Module grounds.
Loss of DTC Memory	To check for the loss of the DTC Memory: 1. Disconnect the MAF sensor. 2. Idle the engine until the Malfunction Indicator Lamp illuminates. The PCM should store a MAF DTC. The MAF DTC should remain in the memory when the ignition is turned OFF. If the MAF DTC does not store and remain, the PCM is faulty.
Additional Checks	.

LIQUIDPROPANEINJECTION

SYMTOMS DIAGNOSTIC CHARTS

No Start

Checks	Action
DEFINITION: The engine cranks OK but does not start.	
Preliminary Checks	• Refer to *Important Preliminary Checks*. • Check fuel level
Control Module Checks	• If a scan tool is available: • Check for proper communication with the PCM • Check the inline fuse in the PCM battery power circuit. Refer to *Engine Controls Schematics.* • Check battery power, ignition power and ground circuits to the PCM. Refer to *Engine Control Schematics.* Verify voltage and/or continuity for each circuit.
Sensor Checks	• Check the Magnetic pickup sensor (RPM). .
Fuel System Checks	**Important**: A closed LPG manual fuel shut off valve will create a no start condition. Verify the manual valve is open; has a c-clip on top of thumb wheel, if there is no c-clip the valve will not open or will only partially open and could cause decreased power. • Check the in tank fuel pump (activate the purge cycle and listen for the fuel pump) • Verify proper operation of the fuel supply valve solenoid at the tank. • Check the fuel system pressures. Refer to the *LPG Fuel System Diagnosis*.

Ignition System Checks	Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions.
	• Check for proper primary ignition voltage
	• Check for the proper ignition voltage output with *J 26792* or the equivalent.
	• Verify that the spark plugs are correct for use with LPG
	• Check the spark plugs for the following conditions:
	  – Wet plugs
	  – Cracks
	  – Wear
	  – Improper gap
	  – Burned electrodes
	  – Heavy deposits
	• Check for bare or shorted ignition wires.
	• Check for loose ignition coil connections at the coil.

LIQUIDPROPANEINJECTION

SYMTOMS DIAGNOSTIC CHARTS

Checks	Action
Engine Mechanical Checks	**Important:** The LPG Fuel system operates in the same fashion as the gasoline fuel supply system. • Check for the following: – Vacuum leaks – Improper valve timing – Low compression – Bent pushrods – Worn rocker arms – Broken or weak valve springs – Worn camshaft lobes.
Exhaust System Checks	• Check the exhaust system for a possible restriction: – Inspect the exhaust system for damaged or collapsed pipes – Inspect the muffler for signs of heat distress or for possible internal failure. • Check for possible plugged catalytic converter. Refer to *Restricted Exhaust System Diagnosis*

LIQUIDPROPANEINJECTION

SYMTOMS DIAGNOSTIC CHARTS

Hard Start

Checks	Action
DEFINITION: The engine cranks OK, but does not start for a long time. The engine does eventually run, or may start but immediately dies.	
Preliminary Checks	• Refer to *Important Preliminary Checks*. • Make sure the vehicle's operator is using the correct starting procedure. • Make sure the purge cycle is being activated • Check to make sure there is adequate fuel supply in the tank
Sensor Checks	• Check the Crankshaft Position (CKP) sensor. • Check the Throttle position (TPS) sensor.
Fuel System Checks	**Important**: A closed LPG manual fuel shut off valve will create an extended crank OR no start condition. • Check the fuel system pressures. Refer to the *Fuel System Diagnosis*. • Verify proper operation of the fuel supply valve solenoid. • Check for restrictions or kinks in the fuel supply line • Check Multivalve electrical connection at the fuel tank for loose connection and/or corrosion in the connectors • Refer to base manual symptom chart for further fuel system checks in the GM MD Service Manual..
Ignition System Checks	Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. • Check for proper primary ignition voltage • Check for the proper ignition voltage output with *J 26792* or the equivalent. • Verify that the spark plugs are correct for use with LPG • Check the spark plugs for the following conditions: – Wet plugs – Cracks – Wear – Improper gap – Burned electrodes – Heavy deposits • Check for bare or shorted ignition wires. • Check for moisture in the distributor cap if applicable. • Check for loose ignition coil connections. **Important**: 1. If the engine starts but then immediately stalls, check the Crankshaft Position (CKP) sensor. 2. Check for improper gap, debris or faulty connections.

LIQUIDPROPANEINJECTION

SYMTOMS DIAGNOSTIC CHARTS

Checks	Action
Engine Mechanical Checks	• **Important:** The LPG Fuel system operates in the same fashion as the gasoline fuel supply system. • Check for the following: – Vacuum leaks – Improper valve timing – Low compression – Bent pushrods – Worn rocker arms – Broken or weak valve springs – Worn camshaft lobes. Ref • Check the intake and exhaust manifolds for casting flash.
Exhaust System Checks	• Check the exhaust system for a possible restriction: – Inspect the exhaust system for damaged or collapsed pipes – Inspect the muffler for signs of heat distress or for possible internal failure. • Check for possible plugged catalytic converter. Refer to *Restricted Exhaust System Diagnosis* or *Exhaust System* in the GM MD Service Manual.
Additional Checks	•

LIQUIDPROPANEINJECTION

SYMTOMS DIAGNOSTIC CHARTS

Cuts Out, Misses

Checks	Action
DEFINITION: A surging or jerking that follows engine speed, usually more pronounced as the engine load increases which is not normally felt above 1500 RPM. The exhaust has a steady spitting sound at idle, low speed, or hard acceleration for the fuel starvation that can cause the engine to cut-out.	
Preliminary Checks	• Refer to *Important Preliminary Checks*.

Ignition System Checks	• Start the engine.
	• Wet down the secondary ignition system with water from a spray bottle, and look/listen for arcing or misfiring as you apply water.
	• Check for proper ignition output voltage with spark tester J 26792.
	• Check for a cylinder misfire.
	• Verify that the spark plugs are correct for use with LPG
	• Remove the spark plugs in these cylinders and check for the following conditions:
	  • Insulation cracks
	  • Wear
	  • Improper gap
	  • Burned electrodes
	  • Heavy deposits
	  • Visually/Physically inspect the secondary ignition for the following:
	  • Ignition wires for arcing, cross-firing and proper routing
	  • Ignition coils for cracks or carbon tracking

Engine Mechanical Checks	• Perform a cylinder compression check.
	• Check the engine for the following:
	  – Improper valve timing
	  – Bent pushrods
	  – Worn rocker arms
	  – Worn camshaft lobes.
	  – Broken or weak valve springs.
	• Check the intake and exhaust manifold passages for casting flash.

Fuel System Checks	• Check the fuel system - plugged fuel filter, low fuel pressure, etc. Refer to *LPG Fuel System Diagnosis*. • Check the condition of the wiring to the low pressure lock-off solenoid.
Additional Check	Check for Electromagnetic Interference (EMI). • EMI on the reference circuit can cause a missing condition. • Monitoring the engine RPM with a scan tool can detect an EMI. • A sudden increase in the RPM with little change in the actual engine RPM, indicates EMI is present. • If the problem exists, check the routing of the secondary wires and the ground circuit.

LIQUIDPROPANEINJECTION

SYMTOMS DIAGNOSTIC CHARTS

Hesitation, Sag, Stumble

Checks	Action
DEFINITION: The vehicle has a momentary lack of response when depressing the accelerator. The condition can occur at any vehicle speed. The condition may cause the engine to stall if it's severe enough.	
Preliminary Checks	Refer to *Important Preliminary Checks*.
Fuel System Checks	• Check the fuel pressure. Refer to *LPG Fuel System Diagnosis*. • Check for low fuel pressure during a moderate or full throttle acceleration. If the fuel pressure drops below specification, there is possibly a faulty low pressure regulator, a restriction in the fuel system, plugged fuel filter or a faulty fuel pump. • Check for excessively high or low fuel trim corrections. • Check fuel supply valve electric solenoid connections at the tank.
Ignition System Checks	Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. If a problem is reported on LPG and not gasoline, do not discount the possibility of a LPG only ignition system failure and test the system accordingly. • Check for proper primary ignition voltage • Check for the proper ignition voltage output with *J 26792* or the equivalent. • Verify that the spark plugs are correct for use with LPG • Check for faulty spark plug wires • Check for fouled spark plugs.
Additional Check	• Check for manifold vacuum or air induction system leaks • Check the generator output voltage.

LIQUIDPROPANEINJECTION

SYMTOMS DIAGNOSTIC CHARTS

Backfire

Checks	Action
DEFINITION: The fuel ignites in the intake manifold, or in the exhaust system, making a loud popping noise.	
Preliminary Check	• Refer to *Important Preliminary Checks*.
Ignition System Checks	**Important!** **LPG, being a gaseous fuel, requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. The ignition system must be maintained in peak condition to prevent backfire.** • Check for proper primary ignition voltage • Check for the proper ignition coil output voltage using the spark tester *J26792* or the equivalent. • Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires. • Check the connection at each ignition coil. • Check for deteriorated spark plug wire insulation. • Check the spark plugs are correct for LPG • Remove the plugs and inspect them for the following conditions: – Wet plugs – Cracks – Wear – Improper gap – Burned electrodes – Heavy deposits
Engine Mechanical Check	• Check the engine for the following: – Improper valve timing – Engine compression – Manifold vacuum leaks – Intake manifold gaskets – Sticking or leaking valves – Exhaust system leakage • Check the intake and exhaust system for casting flash or other restrictions.
Sensor Checks	• Check the Crankshaft Position (CKP) sensor. • Check the HEGO sensors
Fuel System Checks	• Perform a fuel system diagnosis. Refer to *LPG Fuel System Diagnosis*.

LPI LIQUIDPROPANEINJECTION

SYMTOMS DIAGNOSTIC CHARTS

Lack of Power, Sluggishness, or Sponginess

Checks	Action
DEFINITION: The engine delivers less than expected power. There is little or no increase in speed when partially applying the accelerator pedal.	
Preliminary Checks	• Refer to *Important Preliminary Checks.* • Compare the customer's vehicle with a similar unit. Make sure the customer has an actual problem. • Remove the air filter and check for dirt or restriction. • Check the vehicle transmission Refer to the OEM transmission diagnostics.
Fuel System Checks	• Check the manual fuel supply valve, a restricted fuel filter, contaminated fuel, or improper fuel pressure. Refer to *LPG Fuel System Diagnosis*. • Check for the proper ignition output voltage with the spark tester *J 26792* or the equivalent. • Check all air inlet ducts for condition and proper installation. • Check for fuel leaks • Verify that the LPG tank manual shut-off valve is fully open, check for lost c-clip. • Check the fuel pump circuit for loose connection • Check the fuel supply and return lines for restrictions and or kinking and binding.
Sensor Checks	• Check the Heated Exhaust Gas Oxygen Sensor (HEGO) for contamination and performance. Check for proper operation of the MAP sensor. • Check for proper operation of the TPS sensor.
Exhaust System Checks	• Check the exhaust system for a possible restriction: – Inspect the exhaust system for damaged or collapsed pipes – Inspect the muffler for signs of heat distress or for possible internal failure. – Check for possible plugged catalytic converter.
Engine Mechanical Check	Check the engine for the following: • Engine compression • Valve timing • Improper or worn camshaft. Refer to *Engine Mechanical* in the Service Manual.

LIQUIDPROPANEINJECTION

SYMTOMS DIAGNOSTIC CHARTS

Checks	Action
Additional Check	• Check the PCM grounds for being clean, tight, and in their proper locations. • Check the generator output voltage. • If all procedures have been completed and no malfunction has been found, review and inspect the following items: • Visually and physically, inspect all electrical connections within the suspected circuit and/or systems. • Check the scan tool data.

LPI LIQUIDPROPANEINJECTION

SYMTOMS DIAGNOSTIC CHARTS

Poor Fuel Economy

Checks	Action
DEFINITION: Fuel economy, as measured by refueling records, is noticeably lower than expected. Also, the economy is noticeably lower than it was on this vehicle at one time, as previously shown by an by refueling records.	
Preliminary Checks	• Refer to *Important Preliminary Checks*. • Check the air cleaner element (filter) for dirt or being plugged. • Visually (Physically) check the vacuum hoses for splits, kinks, and proper connections. • Check the operators driving habits for the following items: – Is there excessive idling or stop and go driving? – Are the tires at the correct air pressure? – Are excessively heavy loads being carried? – Is their often rapid acceleration? • Suggest to the owner to fill the fuel tank and to recheck the fuel economy. • Suggest that a different operator use the equipment and record the results.
Fuel System Checks	• Check the fuel system pressure. Refer to *LPG Fuel System Diagnosis*. • Check the fuel system for leakage. • Check the fuel injector sealing rings to insure no leakage at the injector • Refer to *Fuel Injector Leakage tests*
Sensor Checks	• Check the Heated Exhaust Gas Oxygen Sensor (HEGO) for contamination and performance. Check for proper operation of the MAP sensor. • Check for proper operation of the TPS sensor.
Ignition System Checks	• Verify that the spark plugs are correct for use with LPG • Check the spark plugs. Remove the plugs and inspect them for the following conditions: – Wet plugs – Cracks – Wear – Improper gap – Burned electrodes – Heavy deposits • Check the ignition wires for the following items: – Cracking – Hardness – Proper connections
Cooling System Checks	• Check the engine thermostat for always being open or for the wrong heat range
Additional Check	• Check the transmission shift pattern. Refer to the OEM Transmission Controls section the Service Manual. • Check for dragging brakes.

LIQUIDPROPANEINJECTION

SYMTOMS DIAGNOSTIC CHARTS

Rough, Unstable, or Incorrect Idle, Stalling

Checks	Action
DEFINITION: The engine runs unevenly at idle. If severe enough, the engine or vehicle may shake. The engine idle speed may vary in RPM. Either condition may be severe enough to stall the engine.	
Preliminary Check	• Refer to *Important Preliminary Checks*.
Sensor Checks	• Check for silicon contamination from fuel or improperly used sealant. The HEGO sensor will have a white powdery coating. The sensor will result in a high but false signal voltage (rich exhaust indication). The PCM will reduce the amount of fuel delivered to the engine causing a severe driveability problem. • Check the Heated Exhaust Gas Oxygen Sensor (HEGO) performance: • Check the Engine Coolant temperature sensor response and accuracy.
Fuel System Checks	• Check for rich or lean symptom that causes the condition. Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem. • Check for a Leaking Fuel Injector seal • Perform a cylinder compression test. Refer to *Engine Mechanical* in the Service Manual. • Check the fuel system pressure. Refer to the *LPG Fuel System Diagnosis*.
Ignition System Checks	• Check for proper primary ignition voltage • Check for the proper ignition output voltage using the spark tester *J26792* or the equivalent. • Verify that the spark plugs are correct for use with LPG • Check the spark plugs. Remove the plugs and inspect them for the following conditions: – Wet plugs – Cracks – Wear – Improper gap – Burned electrodes – Blistered insulators – Heavy deposits • Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires.
Additional Checks	**Important:** The LPG Fuel system operates similar to the gasoline fuel supply system. • Check for vacuum leaks. Vacuum leaks can cause a higher than normal idle and low throttle angle control command. • Check the PCM grounds for being clean, tight, and in their proper locations. • Check the battery cables and ground straps. They should be clean and secure. Erratic voltage may cause all sensor readings to be skewed resulting in poor idle quality..

LIQUIDPROPANEINJECTION

SYMTOMS DIAGNOSTIC CHARTS

Checks	Action
Engine Mechanical Check	• Check the engine for the following: – Broken motor mounts – Improper valve timing – Low compression – Bent pushrods – Worn rocker arms – Broken or weak valve springs – Worn camshaft lobes

LIQUIDPROPANEINJECTION

SYMTOMS DIAGNOSTIC CHARTS

Surges/Chuggles

Checks	Action
DEFINITION: The engine has a power variation under a steady throttle or cruise. The vehicle feels as if it speeds up and slows down with no change in the accelerator pedal.	
Preliminary Checks	• Refer to *Important Preliminary Checks*. • Be sure the driver understands the Torque Converter Clutch operation.
Sensor Checks	• Check the Heated Exhaust Gas Oxygen Sensor (HEGO) performance.
Fuel System Checks	• Check for Rich or Lean symptom that causes the condition. Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem. • Check the fuel pressure while the condition exists. Refer to *LPG Fuel System Diagnosis.* • Check electrical connections at the Multivalve and electric lock off at the tank. • Verify that the LPG manual shut-off valve is fully open, check the c-clip.
Ignition System Checks	• Check for proper primary ignition voltage • Check for the proper ignition output voltage using the spark tester J26792 or the equivalent. • Verify that the spark plugs are correct for use with LPG • Check the spark plugs. Remove the plugs and inspect them for the following conditions: – Wet plugs – Cracks – Wear – Improper gap – Burned electrodes – Heavy deposits.
Additional Check	• Check the PCM grounds for being clean, tight, and in their proper locations. • Check the generator output voltage. • Check the vacuum hoses for kinks or leaks. • Check Transmission
Sensor Checks	• Check the Crankshaft Position (CKP) sensor

LPI LIQUIDPROPANEINJECTION

SYMTOMS DIAGNOSTIC CHARTS

Excessively High Negative or Positive Fuel Correction

Checks	Action
DEFINITION: The scan tool indicates a excessively high negative fuel correction which would indicate the fuel is operating in a **Rich fueling condition** and the controller is trying to correct for the condition, The scan tool indicates a excessively high positive fuel correction which would indicate the fuel is operating in a **Lean fueling condition** and the controller is trying to correct for the condition	
Preliminary Check	• Refer to *Important Preliminary Checks*.
Sensor Checks	• Check for silicon contamination from fuel or improperly used sealant. The HEGO sensor will have a white powdery coating. The sensor will result in a high but false signal voltage (rich exhaust indication). The PCM will reduce the amount of fuel delivered to the engine causing a severe drivability problem. • Check the Heated Exhaust Gas Oxygen Sensor (HEGO) performance: • Check the Engine Coolant temperature sensor response and accuracy.
Fuel System Checks	• Check for rich or lean symptom that causes the condition. Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem. • Check for a Leaking Fuel Injector seal • Perform a cylinder compression test. Refer to *Engine Mechanical* in the Service Manual. • Check the fuel system pressure. Refer to the *LPG Fuel System Diagnosis*.
Ignition System Checks	• Check for proper primary ignition voltage • Check for the proper ignition output voltage using the spark tester *J26792* or the equivalent. • Verify that the spark plugs are correct for use with LPG • Check the spark plugs. Remove the plugs and inspect them for the following conditions: – Wet plugs – Cracks – Wear – Improper gap – Burned electrodes – Blistered insulators – Heavy deposits • Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires.
Additional Checks	**Important:** The LPG Fuel system operates similar to the gasoline fuel supply system. • Check for vacuum leaks. Vacuum leaks can cause a higher than normal idle and low throttle angle control command. • Check the PCM grounds for being clean, tight, and in their proper locations. • Check the battery cables and ground straps. They should be clean and secure. Erratic voltage may cause all sensor readings to be skewed resulting in poor idle quality.

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SYMTOMS DIAGNOSTIC CHARTS

Checks	Action
Engine Mechanical Check	• Check the engine for the following: – Broken motor mounts – Improper valve timing – Low compression – Bent pushrods – Worn rocker arms – Broken or weak valve springs – Worn camshaft lobes

Approximate Properties of LP-Gases

(Commercial Propane)

C_3H_8

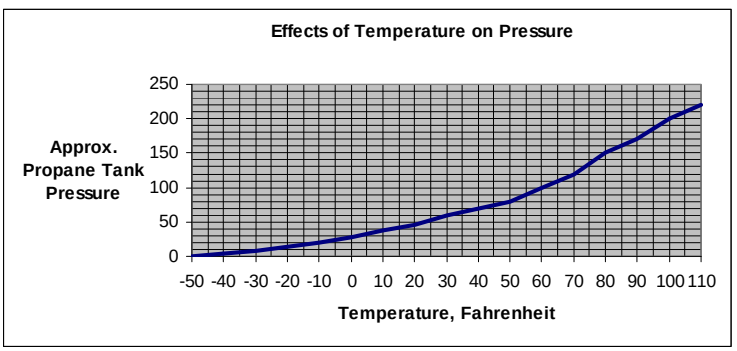
Specific gravity of liquid (water = 1) at 60 degrees F.		0.504
Initial boiling point at 14.7 psia, (displayed in degrees F.)		- 44.0
Weight per gallon of liquid at 60 degrees F. (displayed in pounds)		4.24
Cubic ft. of vapor per gallon at 60 degrees F.		36.38
Cubic ft. of vapor per pound at 60 degrees F.		8.66
Specific gravity of vapor (air = 1) at 60 degrees F.		1.50
Ignition temperature in air, degrees F.		920 to 1120
Maximum flame temperature in air, degrees F.		3,595
Limits of flammability in air Percent of vapor in air/gas mixture:		
	Lower	2.15
	Upper	9.60
Air/Fuel ratio by volume		15.6: 1
Air/Fuel ratio by weight		24:1
Octane number as it relates to gasoline		98 to 102
Heating values:		
	BTU per cubic foot	2,488
	BTU per pound	21,548
	BTU per gallon	91,500
Chemical formula		C_3H_8
Vapor pressure in psig		
	70 degrees F	127
	100 degrees F	196
	105 degrees F	210

LPI® Fuel System

Fuel Pressure:
Fuel pressure should be measured at the fuel pressure test port commonly found on the fuel pressure regulator. The same as fuel injected gasoline vehicle the in-tank fuel pump provides an amount of fuel pressure and is required to maintain the necessary amount of fuel delivered during all driving conditions. The difference in checking fuel pressure of the LPI fuel system is propane is stored as a liquid under moderate pressure and the moderate pressure is different depending on temperature and the blend of hydrocarbons the fuel is refined with at the refinery. There are specifications which each refinery has to meet so the variance in this area of fuel is not much of an issue.

There are three considerations to document when measuring fuel pressure

1. Tank pressure: The amount of pressure in the tank at the time fuel pressure is measured
    a. Tank pressure varies, see chart below



2. Purging boost pressure: The amount of pressure measured when the purge cycle has been initiated by turning the ignition key to the "ON" position. Normally ranges from 15 to 30 P.S.I. and is always lower than operating boost pressure due to the purge solenoid is open to allow more volume of fuel flow.
3. Operating boost pressure: The amount of pressure measured when the engine is running. It is important to note that battery condition and charging system condition can affect the operating pressure so if low pressure is experienced verify that there is no failure in the charging system, battery or voltage supply to the fuel pump.

NOTE: Pump boost pressure is the amount of pressure added by the pump over actual internal tank pressure. Pump boost pressure ranges from 50 to 70 P.S.I. with a minimum acceptable boost of 40 P.S.I.

LIQUIDPROPANEINJECTION
SYMTOMS DIAGNOSTIC CHARTS

Reading & understanding data stream information from the scan tool

Scan tools have made a technician's life so much easier because information is easy to access and there is so much information to review to make your diagnosis quicker and easier. However, it is always recommended that replacement of good components is a risk if a clear understanding of what the data you read means and how the components of electronic engine control works; sensors, actuators and the control computer.

The following relates to the LPI fuel system diagnosis and may not be equal on a gasoline system. The LPI system works identical to the gasoline fuel injection system it replaced but some control data may differ slightly.

The very first piece of information to eliminate is fuel pressure. A good understanding of the LPI fuel flow control as described in the previous page is required and it is recommended if no trouble codes exist and there is a performance complaint that fuel pressure be verified first.

If there are any diagnostic trouble codes retrieved from the PCM (Power-train control module) take a close look at the codes and consider each one carefully. Some codes indicate a gross error with a sensor therefore you would want to investigate the condition of the sensor, it's electrical connector and sometimes the wiring going from the PCM to the sensor. You may also be able to perform a test on the sensor to verify fault or no fault.

After fuel pressure is considered within specifications the following data should be reviewed first.

Fuel Control

1. LTFT B1 (Long term fuel trim, bank one)
    a. Long Term means adjustment to fuel control over time. It may take a few hours or a few days to stabilize completely however once the Short Term values are stable around "0" the Long Term Fuel Trims should have learned enough to be stable.
    b. Values should range between -10 to +10 but not more than 10 points difference from Bank One to Bank Two
    c. The value is shown from -25 to +25 and 0 is the center of the range of fuel control.
        i. If the value is a negative number the fuel control is biased rich and the controller is subtracting fuel. Note: This does not mean the system is running rich but is controlling a rich fuel delivery and is subtracting some fuel to maintain the best overall control of emissions through fuel control.

ii. The air filter could be dirty causing a biased rich system. If the value is a positive number (if the value does not have the – negative mark in front of it, it is a positive value) the opposite applies, the fuel control is lean and the controller is adding fuel to maintain the best overall control of emissions through fuel control. The fuel filter could be getting clogged, fuel pressure could be low and etc…
iii. If fuel control reaches -25 or +25 the limit of fuel control is at the maximum control capacity and a diagnostic trouble code will be logged and if the condition continues a MIL (Malfunction Indicator Lamp/Check Engine Light) will illuminate to warn the driver of a failure and the need to take the vehicle in for service.

2. LTFT B2 (Long term fuel trim, bank two) See number one
3. STFT B1 (Short term fuel trim, bank one)
    a. Short term means current time adjustments to fuel control; until the long term fuel control has learned, short term will provide the range of fuel control as needed. Short term also has a range of -25 to +25 and 0 being the center of range of fuel control
    b. Short term will more commonly move around from a negative number to a positive number or actually toggle above and below zero as required to control fuel for best exhaust emissions. This movement is normal and the range could vary depending on where the long term fuel trims are.
4. STFT B2 (Short term fuel trim, bank two)
5. PW 1 (Pulse width, bank one)
6. PW 2 (Pulse width, bank two)
7. O2 B1S1 (Heated oxygen sensor, bank one, sensor one)

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SYMTOMS DIAGNOSTIC CHARTS

LPI Recommended Tools

99000010	Pressure test gauge with bleeder - no hoses
99000011	1 3/4" ACME to No 4 Flare Fuel Evacuation Adaptor
99000012	Evacuation Valve hose with 90 degree special fitting
99000013	30 foot Evacuation hose extension
99000014	Evacuation hose (pigtail) for fuel supply valve connection
99000015	Tank pressure gauge with bleeder - no hoses
99000016	Fuel system pressure testing hose for pressure test gauge with special adaptor for pressure regulator test port
99000017	Adaptor, No 4 flare to 3/8 male flare
99000025	Storage case
10:01-45-LPI tool kit	Complete Kit (all above parts)
90700002	Hose end assembly tool for 3/8" blue filler hoses
90700000	Hose end assembly tool for 3/16" green or black hoses
Other Recommended tools	**Purchase from GM and/or local tool man (Snap-On or Mac)**
	Diagnostic Scan Tool - GM Tech II or equivalent
	Digital Multi-meter
	Metric hand tools
	Tee-handle type Allen wrenches
	1/4" or 3/8" Torque wrench (inch lb or NM)
	GM Medium Duty Truck Service & Diagnostic Manuals